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PROCEEDINGS

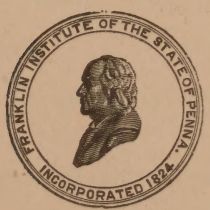
OF THE

CHEMICAL SECTION

OF THE

FRANKLIN INSTITUTE.

(VOL. IV.—JAN.-DEC., 1892.)



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By-Laws

of the

Chemical Section

of the

Franklin Institute.

I. In accordance with article xi, section 4, of the by-laws of the institute, only members of the institute may be elected to membership in the section; but sections are empowered to appoint associates, corresponding members and honorary members; *provided* that such appointments are sanctioned by the board of managers. Associates shall have the privilege of attending the meetings of the section and of participating in its scientific discussions, but shall not be entitled to vote. They shall be required to pay an annual assessment of two dollars ($2), payable in accordance with article iii.

II. The committee on admission shall consist of seven members. They shall be elected annually. Four members shall constitute a quorum at all meetings of this committee. The adverse vote of two members shall be a rejection of a candidate. Applications for admission to the section shall be in writing and signed by one member of the section. They shall be referred to this committee, after having been read before the section at a stated meeting. It shall be the duty of the committee, after careful consideration of the fitness of candidates, to vote on each name separately by ballot. This proceeding shall be secret and confidential. The committee shall send to the secretary of the section the

names and addresses of the candidates elected. The committee shall have power to make its own rules of procedure.

III. Every member shall pay an initiation fee of one dollar ($1), and an annual contribution of two dollars ($2) in advance; but those elected to membership after October 1st shall pay no yearly dues for that year.

IV. Candidates elected to the section shall become members on payment of the initiation fee. If this fee is not paid within six months, the candidate's election shall be considered void. If the annual dues are not paid for a period of two years, due notice shall be given the member, and his name shall be stricken from the list.

V. The chemical apparatus, chemicals and other preparations belonging to the section, shall be under the care of the conservator, whose duty it shall be to see that they are kept in order and, if needed, readily accessible at the meetings of the section. He shall also attend to any minor repairs that may be necessary, and shall make an annual report to the section.

VI. The apparatus, reagents, etc., shall not be removed from the Franklin Institute building without consent of the conservator.

VII. A standing committee of two members shall be appointed yearly, who, with the secretary, shall be empowered to transact all financial business of the section, outside of the matters embraced in the duty of the treasurer. They shall pass all bills and shall audit the treasurer's account at the end of every year.

VIII. The stated meetings of the section shall be held on the third Tuesday of each month, except during July and August. Special meetings may be called by the secretary, at any time, on application of seven members.

IX. At the stated meeting in November, nominations shall be made, and at that in December, an election shall take place, for the following officers for the ensuing year:

President,
Two vice-presidents,
Secretary,
Treasurer,
Conservator.

The annual reports of the standing committees and officers shall be read at the December meeting.

X. The order of business for stated meetings shall be as follows:

(1) Correction of minutes of previous meeting.
(2) Nominations for membership.
(3) Report of committee on admissions.
(4) Reports of officers and correspondence.
(5) Reports of standing committees.
(6) Reports of special committees.
(7) Deferred business.
(8) New business.
(9) Communications and discussions.

XI. A quorum for the transaction of business shall consist of seven members.

XII. These by-laws may be temporarily suspended at any meeting of the section by unanimous consent of the members present. Amendments of a more permanent character may be made at any stated meeting by a vote of two-thirds of the members present; *provided*, that such amendments shall have been presented in writing and read before the section at a previous stated meeting.

Chemical Section.

Officers—1892.

President,	Dr. Wm. H. Wahl.
Vice-presidents,	Dr. E. F. Smith, Dr. W. H. Greene.
Secretary,	Prof. Wm. C. Day.
Treasurer,	Dr. H. W. Jayne.
Conservator,	Dr. Wm. H. Wahl.

LIST OF MEMBERS.

A.

Allen, A. W., ... Pencoyd Iron Works, Pencoyd, Pa.
Allen, W. N., ... 2 Chestnut Street.

B.

Bower, Henry, ... 28th and Gray's Ferry Road.
Bower, W. H., ... 28th and Gray's Ferry Road.
Boyer, Charles L., ... 528 Linden Street, Camden, N. J.
Browning, G. Genge, ... 44 North Front Street.
Bullock, Charles, ... 528 Arch Street.
Bullock, William A., ... 528 Arch Street.
Beringer, G. M., ... 5th and Federal Streets, Camden, N. J.

C.

Carter, John E., ... Coulter and Knox Streets, Germantown.
Cresson, Dr. C. M., ... 413 Locust Street.
Clarkson, Philip H., ... Quaker City Dye Works, 110 Oxford St.
Comer, Harris, ... 624 South Washington Square.
Campbell, J. H., ... Kingman, Mojave County, Arizona.

D.

Day, Prof. Wm. C., ... Swarthmore College, Pa.

E.

Eastwick, J. H., ... Melon Street, ab. Margaretta, East Liberty, Pittsburgh, Pa.
Eastwick, A. T., ... Melon St., East End, Pittsburgh, Pa.

F.

Fisher, R. A., ... 2239 St. Alban's Place.
Frankel, Lee K., ... University of Pennsylvania.

G.

Galt, Hugh A., ... Kalion Chemical Company, 32d St. and Gray's Ferry Road, Philadelphia.

Gray, Prof. Albion D., ... Penn Charter School, 8 S. Twelfth St.
Greene, Dr. Wm. H., ... 204 North Thirty-Sixth Street.
Genth, Dr. F. A., ... 3937 Locust Street.
Garrison, F. Lynwood, ... Radnor, Delaware County, Pa.

H.

Haines, Reuben, ... 738 Sansom Street.
Hall, Prof. L. B., ... Haverford College, Pa.
Hough, Oliver, ... 325 South Sixteenth Street.
Hooker, Dr. S. C., ... Franklin Sugar Refinery.
Hunter, Thomas G., ... Fifty-fifth Street and Paschall Avenue.

I.

Ives, Frederick E., ... Crosscup & West, Ninth and Filbert Sts.

J.

Jayne, E. C., ... 242 Chestnut Street.
Jayne, H. W., ... 931 North Broad Street.

K.

Keller, Dr. H. F., ... Central High School.
Keiser, Dr. E. H., ... Bryn Mawr College.

L.

Luthy, Dr. Otto, ... 2336 Fairmount Avenue.
Lea, M. Carey, ... 430 Walnut Street.

M.

Matos, L. J., ... 3943 Fairmount Avenue.
Mason, Dr. W. P., ... Troy, N. Y.
MacFarlane, Wm. W., ... J. M. Sharpless & Co., Chester, Pa.
Morris, Dr. L. I., ... 2505 Oxford Street.
Morton, Prof. Henry, ... Stevens Inst. Tech., Hoboken, N. J.
Mackensie, A. S., ... Bryn Mawr College, Pa.

N.

Newbold, Thomas N., ... 608 South Forty-second Street.
Newhall, George M., ... 136 South Fourth Street.

P.

Palmer, T. C., ... P. O. B. 19, Chester, Pa.
Pemberton, H., ... 1947 Locust Street.
Pemberton, H., Jr., ... 1947 Locust Street.
Phillips, George B., ... 622 Race Street.

R.

Rand, Theodore D., ... 17 South Third Street.
Rowland, W. L., ... 4800 Chester Avenue.
Richards, Prof. Joseph, ... Lehigh University, Bethlehem, Pa.
Rosengarten, Frank H., ... 17th and Bainbridge Streets.

S.

Schaffer, Dr. Charles, ... 1309 Arch Street.
Semper, C. J., ... 505 South Forty-first Street.
Seal, Alfred N., ... 1418 Bouvier Street.
Sadtler, Samuel P., ... 1042, Drexel Building.
Smith, Prof. Edgar F., ... University of Pennsylvania.
Salom, Pedro G., ... 926, Drexel Building.
Shapleigh, Waldron, ... Welsbach Incandescent Electric Light Co., Gloucester, N. J.
Strombeck, Dr. Hans v., ... 104 Bank Street, New York.
Schanche, Hermann, ... Harrison Bros. & Co., 36th and Gray's Ferry Road, Phila.

T.

Trimble, Prof. H., ... 145 North Tenth Street.
Thomas, Prof. N. Wiley, ... Girard College.
Tuttle, Dr. D. K., ... U. S. Mint, Philadelphia.
Terne, Dr. Bruno, ... Baugh & Sons' Chemical Works.

W.

Whitney, Asa W., ... 1815 Vine Street.
White, George W., ... Camden Iron Works, Camden, N. J.
Webster, George C., ... Media, Pa.
Wahl, Dr. William H., ... Franklin Institute.
Weikel, W. D., ... Merchantville, Camden Co., N. J.
Wyeth, F. H., ... 11th Street and Washington Avenue.
Wolf, Dr. T. R., ... Newark, Del.
Wiegand, S. Lloyd, ... 146 South Sixth Street.
Whitehead, Cabell, ... Mint Bureau, Washington, D. C.
Williams, George Guest, ... Twenty-fourth and Bainbridge Streets.

Y.

Young, S. W., ... Swarthmore, Pa.

LIST OF PRINCIPAL CHEMICAL JOURNALS, ETC., IN THE LIBRARY OF THE INSTITUTE

American Chemical Society, New York City.
Analyst, London, England.
Canadian Record of Science, Boston.
Annalen der Chemie, Leipzig, Germany.
Annales de Chimie et de Physique, Paris, France.
Annalen der Physik und Chemie, Leipzig, Germany.
Chemical Society Journal, London, England.
Chemical News, London, England.
Chemical Trade Journal, Manchester, England.
Dingler's Polytechnisches Journal, Stuttgart, Germany.

Jahresbericht u. d. Fortschr. der Chemie, Giessen, Germany.
Journal for Analytical Chemistry, Easton, Pa.
Journal für Praktische Chemie, Leipzig, Germany.
Moniteur Scientifique, Paris, France.
Nature, London, England.
Scientific American Supplement, New York.
Society of Chemical Industry, London, England.
Wagner's Jahresbericht, Leipzig, Germany.
Zeitschrift für Analytische Chemie, Wiesbaden, Germany.
Zeitschrift für Angewandte Chemie, Berlin, Germany.
Zeitschrift für Krystallographie und Mineralogie, Leipzig, Germany.
Zeitschrift für Physikalische Chemie, Leipzig, Germany.
Zeitschrift für Physilogische Chemie, Strassburg, Germany.
Chemisches Centrallblatt, Hamburg, Germany.

OFFICERS FOR 1893.

President,	Dr. Wm. H. Greene.
Vice-Presidents,	Mr. Henry Bower, Dr. E. K. Tuttle.
Secretary,	Dr. W. C. Day.
Treasurer,	Dr. H. W. Jayne.
Conservator,	Dr. Wm. H. Wahl.

PROCEEDINGS

OF THE

CHEMICAL SECTION

OF THE

FRANKLIN INSTITUTE.

[*Stated meeting held Tuesday, January 19, 1892.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, January 19, 1892.

Dr. W. H. WAHL, President, in the chair.

The election of officers, which was postponed from the December meeting, was first taken up, and on motion the Secretary was directed to cast the vote of the Section for all the nominees.

Mr. Chas. S. Boyer read a paper giving the results of a number of analyses made by him of egg yolk. It was referred for publication in the *Journal*.

Mr. H. Pemberton, Jr., followed with two communications, one on gas analysis, including the description of a new form of gas measuring apparatus, which simplified the reduction of volumes to the standard conditions of temperature and pressure. The second paper was a description of a rapid method for the determination of carbonic acid gas. Both were referred for publication in the *Journal*.

Dr. Wahl then presented a paper presenting a new interpretation of the chemical reactions which take place in the operation by which aluminium is deposited in the electrolytic process of manufacture. The paper included a complete description of the process as it is at present carried out, and was followed by the explanation in detail of the views entertained by the author on this interesting subject. Dr. Wahl also exhibited a number of aluminum articles recently turned out by the Pittsburgh Reduction Company. The paper was referred for publication, and after some discussion upon it, and an inspection of the exhibit, the Section adjourned.

WM. C. DAY, *Secretary*.

PROCEEDINGS.

[*Stated meeting, held Tuesday, February 16, 1892.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, February 16, 1892.

Dr. W. H. WAHL, President in the chair.

The Treasurer made the following report for the year 1891:

Cash on hand January 1, 1891,			$97 33
Received:			
By initiation fees,		$18 00	
Dues, 1890,	$6 00		
1891,	138 00		
1892,	2 00		
		146 00	
			164 00
			$261 33
Expended;			
Printing by-laws,		$12 99	
Addressing and postage,		31 50	
Printing for secretary,		18 75	
Envelopes and postage for treasurer,		3 94	
Friedlander's bill,		62 30	
			129 48
Cash on hand January 1, 1892,			$131 85
Outstanding dues, 1890,			$2 00
dues, 1891,			14 00
initiation fees,			2 00
			$18 00

The resignation of Dr. Persifor Frazer was read and accepted.

A number of bills, the contraction of which had already been authorized by the Section, were presented, and on motion it was voted that the Treasurer be authorized to pay them.

The Treasurer also presented a bill for expenses incurred in binding and in preparing for distribution among the members the copies of vol. iii, 1891, of the Proceedings of the Section. The President explained that these expenses properly belonged to the Section rather than to the Institute and on motion the payment of the bill was authorized.

Dr. E. H. Keiser gave an account of an investigation upon the composition of the explosive copper and silver compounds of acetylene. The paper will be published at length subsequently. The results obtained are in brief as follows: When pure acetylene is conducted into an ammoniacal solution of silver nitrate, the yellowish white precipitate which is formed has, when dried, the composition represented by the formula C_2Ag_2. It may in fact be regarded as acetylene in which both hydrogen atoms have been replaced by silver. The formula that has generally been adopted for this substance is $C_2H_2Ag_2O$. But such a compound contains only 83·71 per cent. of silver, whereas in three specimens of the substance prepared by Dr. Keiser the quantity of silver found was 89·32, 89·44 and 89·60 per cent. The formula C_2Ag_2 requires 89·9 per cent. silver. That the compound contains no hydrogen was shown by exploding a weighed quantity of it in a glass tube which had been exhausted with an air-pump; no hydrogen was obtained.

A study of the compound formed by acetylene in ammoniacal cuprous chloride showed that it was similar in composition to the silver compound, although in this case it was much more difficult to obtain the substance perfectly free from water. Analyses showed that the composition of the substance after it had been dried in a vacuum over sulphuric acid, agreed very closely with what would be required by the formula $C_2Cu_2.\frac{1}{2}H_2O$. The investigation will be continued.

The paper was listened to with close attention by the members present, and was followed by a number of questions and comments.

Dr. Bruno Terne followed with a paper, entitled "Notes on Iron in Bone Black." It was of special interest in connection with the application of bone black in sugar refining, and was discussed by the author and Dr. S. C. Hooker, the latter from the standpoint of an expert in sugar refining. Dr. Hooker stated that in cases where the percentage of iron reached a sufficiently high limit, it would be imparted to the sugar solution rather than abstracted from it, and hence such bone black would do harm rather than good. He also stated that sugar itself in solution has the power of dissolving iron, hence a further reason for the importance of eliminating iron in the manufacture of bone black.

Dr. Terne's paper was referred for publication in the *Journal*.

The Section then adjourned.

WM. C. DAY, *Secretary*.

ANALYSIS OF "EGGIO:" A PREPARATION OF THE YOLK OF EGGS.

By Charles S. Boyer.

[*Read at the stated meeting of the Chemical Section, January 19, 1892.*]

About a year ago I had occasion to make several analyses of "eggio"—a preparation of the yolk of eggs. Aside from the researches on pure egg yolk, I was unable to find any published analysis of the commercial product, and it may be of interest to place on record the results of my analysis. The ingredients for which the eggio was examined were water, ash and fatty acids, these being the only constituents of value in the dressing of fine leathers, for which purpose most of it is used.

The method which I used was as follows: Two to four grammes of the eggio were dried in a weighed platinum dish for two to four hours at 110° C. and weighed, the loss being regarded as water. In order to facilitate the drying, a weighed quantity of coarse, ignited sand, or small pieces of infusible glass, was spread over the bottom of the dish. This dry residue was then ignited at a red heat and the resulting ash was calculated as mineral matter. The ash was light gray to white in color and was tested qualitatively for lime, but in no case was any found.

For the fatty acids, ten grammes of the eggio were placed in a flask of about 350 cc. capacity and 150 cc. of ether poured over it. The flask was then connected with a reflux condenser and heated on a water-bath for two hours, being shaken every now and then to break up the white albuminous mass which collected in the bottom of the flask. The solution in the flask was allowed to cool and 50 cc. of the supernatant liquid removed by a pipette, replaced by 50 cc. of fresh ether, and the flask again heated for one hour, with frequent shaking as before. The flask was then allowed to cool and the clear yellowish liquid drawn off and added to the 50 cc. previously withdrawn. The contents in the flask were twice washed with ether and the ethereal layer added

to the first. This ethereal extract was placed in a flask and a portion of the ether distilled off. The solution was then placed in a weighed platinum dish and the remainder of the ether driven off on a water-bath. The residue in the dish was dried in an air-bath at 105° C., to expel any adhering water, and weighed.

The method was tried on a sample of fresh egg yolk and yielded 20·00 per cent. fatty acids, while in König's *Nahrungs- und Genussmittel* the percentage of fatty acids in pure egg yolk is given as 20·3. I, therefore, concluded that the method was sufficiently accurate for technical purposes.

As a result of the analyses of five samples of different lots of eggio by the above method, I obtained the following results:

	I. *Per Cent.*	*II.* *Per Cent.*	*III.* *Per Cent.*	*IV.* *Per Cent.*	*V.* *Per Cent.*
Water,	55·64	56·81 56·06	56·91 56·45 56·79	54·20	53·75 53·62
Ash,	11·73 11·80	19·25	9·46 9·47	13·67	16·35
Fatty acids,	14·66	—	—	16·00	15·23

In order to compare these results with those found for pure egg yolk, I give the following analyses, the first from König's *Nahrungs- und Genussmittel* and the second obtained by the writer with the above method.

	I. *Per Cent.*	*II.* *Per Cent.*
Water,	51·8	53·72
Salts,	1·0	—
Fatty acids,	20·3	20·00

By comparing these values with those above, it is found that commercial eggio contains from two to five per cent. more water, and three and one-half to six per cent. less fatty acid, than are found in pure egg yolk. The salts are sodium salts added in order that the eggio may be preserved from putrefaction.

As soon as time will permit, I hope to be able to communicate the exact composition of the ash of eggio, which I think will be of value in supplementing the above partial analysis of this product.

PROCEEDINGS.

[*Stated meeting held Tuesday, March 15, 1892.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, March 15, 1892.

Dr. W. H. WAHL, President, in the chair.

Dr Wahl called attention to a number of bills for subscriptions to journals, the contraction of which had already been authorized. On motion, the Treasurer was instructed to pay them.

Dr. S. C. Hooker read a very interesting paper on derivatives of lapachic acid. Dr. Hooker included in his paper a *résumé* of some of the more important results obtained by him during the past two years and also contrasted the views entertained by E. Paterno and himself. The paper was received with marked attention and interest by the members present. Specimens of the substances discussed were exhibited. The complete publication of these results will be deferred by the author for some time.

The section then adjourned. WM. C. DAY, *Secretary.*

NOTES ON IRON IN BONE-BLACK.

BY DR. BRUNO TERNE.

The freshly-prepared bone-black of the market yields on an average from 0·1 to 0·3 per cent. of iron in the form of metallic iron, originating principally from iron mixed with the bones gathered up by the junk dealers, another portion coming from the wear and tear of the bone crushers and mills, and a very little from the iron vessels used in burning the bones.

Having been in charge for the last fifteen years of one of the largest plants for manufacturing bone-black, I had never experienced any trouble with our product, on account of the iron, until several months ago, when one of our patrons complained of an excess of iron in our black, which, according to his investigation, had run up in one instance to one-half of one per cent.

This complaint was coupled with the assertion that an increase of 0·25 per cent. of iron above the average would materially impair the process of refining sugar.

This charge coming from a source commanding serious consideration, caused us to look into this matter thoroughly, but an examination of the literature of sugar refining, covering a period commencing with 1872 (*Wagner's Jahresberichte*) up to date, failed to disclose a single case in corroboration of the above-cited assertion.

The more I thought over the matter the more I became convinced that the complaint made against our black, that it impaired the work of refining sugar liquors, was merely a convenient pretext to shield some irregularities in the process of refining, which otherwise would have to be shouldered at home. We all know that organic acids will dissolve iron, but in refining sugars the liquors should be free from acids or at least nearly made free by previous neutralization; the traces of free organic acids must certainly all be absorbed by the six to seven per cent. of carbonate of lime contained in fresh bone-black. The fact that in discarded black the yield of carbonate of lime is reduced to three or four per cent., and the yield of iron considerably raised, demonstrates clearly that fresh black operates to free sugar liquors from iron as well as other impurities.

In order to ascertain what effect a solution acidified with organic acid would have on the iron in bone-black, I prepared two solutions of citric acid containing respectively 0·1 per cent. and 0·25 per cent. of free acid.

The acidity of these solutions is so great that no sugar liquor entering filters will ever approach it in acidity.

I selected a black which had given by analysis a yield of 0·5 per cent. of iron, and made the following experiments:

	Per Cent.
(*a*) 5 grammes of black with 500 cc. citric acid solution of . .	0·1
(*b*) 10 " " " " " . .	0·1
(*c*) 5 " " " " " . .	0·25
(*d*) 10 " " " " " . .	0·25

I exposed the four flasks on the top of a steam heater for twenty-four hours to a temperature of 150° to 160° F., after which I tested the still acid solution for iron with potassium sulphocyanide and potassium ferridcyanide, but no trace of iron could be found in the solution.

Not satisfied with this I kept the flask for eighteen hours on a steam-bath at a temperature of 200° to 212° F.; the results of the two experiments were absolutely the same.

To operate on a sample of black large enough to place the result of the experiment beyond any doubt, I took 250 grammes of the same black yielding one-half per cent. of iron and treated the same with two litres of citric acid solution containing 0·25 per cent. free citric acid, for twenty-four hours on the steam-bath at nearly 212° F.

At the end of this time the acidity of the solution had completely disappeared and the absolutely neutral solution showed not a trace of iron with the most sensitive reagents (potassium sulphocyanide and potassium ferridcyanide).

I went still a step further and prepared a solution of iron in citric acid, 200 cc. of which contained 1·01 grammes of iron. I took 100 cc. and diluted to 500 cc.; I mixed the dark-yellow solution in a flask with 500 grammes of fresh regular sugar-house black, boiled up for thirty minutes, filtered and obtained a perfectly limpid solution which contained not a trace of iron.

This experiment proved to my own satisfaction that an accidental excess of 0·25 per cent. of iron in fresh black could not be charged with creating irregularities in the process of refining sugar liquors. But not being an expert in sugar refining I submitted this problem with the above results of my own researches to my friend, Dr. Arno Behr, now Secretary and Treasurer of the Chicago Sugar Refining Company, an acknowledged expert in this branch of chemical industry at home and abroad. I submit herewith an abstract of his letter:

CHICAGO, January 4, 1892.

MY DEAR DR. TERNE: * * * "Iron is a very objectionable substance to have in filtered sugar solutions, because the refined soft sugars which are produced from such solutions take on a more or less gray appearance, which reduces their value considerably compared with others, which are free from iron and of a bright yellow color.

"Colonial raw sugars contain sometimes a considerable amount of iron, and in the absence of good chemical methods for the removal of this iron from the unfiltered liquor, the refiner relies on the bone-black to absorb it.

"In some refineries the sugar solutions enter the black practically neutral, in others they are left a little acid, but this is of no consequence, for you have found yourself that new black will absorb the iron even from a strongly acid solution. Even old working bone-black contains enough carbonate of lime (three to four per cent.) to neutralize any considerable excess of acid. There is, however, a considerable difference in the behavior of new and old black. Say you want to filter 100 pounds of dry sugar over 100 pounds of bone-black. Say this sugar contains two to three-hundredths of one per cent. of Fe_2O_3. The solution will come from the new black absolutely free from iron, while from the old black half of it perhaps will be free, and the other half will contain it in increasing quantities.

"This will happen with properly neutralized liquor and without any fermentation having occurred. Even if the sugar solution enters the black free from iron, towards the end it will come from the old black containing iron.

"It works this way without any attempt having been made to wash the liquor out of the black. As soon as that is done matters become worse. Even from very good black the diluted sugar solution carries away a certain amount of iron.

"Now in working it is found that the amount of iron increases in the black with its age, and that in the same proportion the amount of iron increases in the liquor. There is no way of removing the iron once absorbed by the black.

"There are three sources of iron in the black:

(1) "The iron originally contained in the black.

(2) "The iron in the raw sugar.

(3) "The iron taken up by the liquors and the bone-black in the sugar refining.

"The liquor has very little chance to dissolve iron, but the bone-black gets more or less of it by its passages through the kilns. The iron in the raw sugar the refiner

has to take and make the best of, but in the case of the iron in the new black he will naturally fall back on the bone-black manufacturer and I do not blame him.

"It is reasonable to expect that a black with 0·1 per cent. Fe will furnish iron-free liquors for a longer time than one with 0·3 per cent. Fe. Most of the iron in new bone-black is in the metallic state and can be removed by running the crushed black over a magnetic separator.

"With best regards, Yours very truly,

"ARNO BEHR."

Certainly every one will agree with my friend, Dr. Behr, that 0·1 per cent. impurity of anything is to be preferred to 0·3 per cent.; the self-interest of the manufacturer will command the adoption of such means as to keep the percentage of iron as low as possible.

In the interest of manufacturers of bone-black everywhere, I thought it, however, of sufficient importance to refute the theory that an accidental excess of a fraction of a per cent. over the acknowledged unavoidable proportion of iron in new black, could be held accountable for any disturbance in the process of sugar refining, and to have my protest recorded with the section against such a claim.

This point has been fairly covered by my own experiments, and is clearly corroborated by the opinion of one of the most competent sugar chemists of this country.

Regarding the chemical methods of iron determination which are far too laborious to perform every day, I have been trying to find a method which could be carried on with sufficient accuracy without requiring previous chemical training.

I found that a boy, with the help of a magnet, could, by exercising the necessary care, make a determination, sufficiently accurate for the daily control of a bone-black mill.

Take 100 grammes of the black and spread it in a thin layer over a sheet of white paper, then plow through it with a good magnet (I am using a six-inch horseshoe) and it will be found that most of the iron will be picked up at the first few passes.

After repeating the passes of the magnet in every direction, carefully observing that no part of the mass is missed, in a very few minutes all the iron will have been gathered on the watch glass ready for weighing. The results thus obtained come sufficiently close to those obtained by chemical test to serve as a control upon the process of manufacture, as the following examples will show:

The following tests have all been made within the last four months:

	By Chemical Analysis. Per Cent. Iron.	*By Magnetic Test. Per Cent. Iron.*
October, 1891,	0·360	0·410
1891,	0·160	0·219
December, 1891,	0·387	0·501
January, 1892,	0·100	0·130
1892,	0·169	0·213
1892,	0·080	0·107
1892,	0·199	0·224

While the magnetic test is invariably too high, it is sufficiently close to control the work of the black mills. The adherence of particles of carbon to the iron fully explains this result.

Regarding the chemical determination of iron, I consider a previous incineration of the black necessary, because there is a possibility that traces of organic matter left in the fresh black may be mistaken for iron by the reduction of the potassium permanganate.

On the use of OIL in AMMONIA GAS COMPRESSORS and its INFLUENCE on the EFFICIENCY of the COMPRESSORS.*

By Dr. Hans von Strombeck.

At the suggestion of Mr. Louis Block, Chief Engineer of the De La Vergne Refrigerating Machine Company, of New York, I conducted a series of experiments in the year 1887 for the purpose of determining the influence, which the injection of the oil into the compressor of this company's machine has on the efficiency of the gas pump. There had been considerable controversy on this point, and it was with the view of settling finally this question of dispute that a sufficient number of carefully conducted tests under varying conditions of pressure and temperature were made. The results of my investigations are laid down in the following treatise, accompanied by a number of tables and curves, which will fully illustrate the matter.

In the old form of the De La Vergne single-acting compressor, the cold oil was drawn by a plunger-pump from a reservoir or tank (the low-pressure or vacuum tank), which communicated by means of a pipe with the suction side of the machine, thus maintaining in the tank a constant pressure equal to that under which the liquid ammonia evaporated in the cooling-coils of the system. The oil-pump on its down-stroke discharged the oil thus drawn from the low-pressure tank into the gas-compressor, while the piston of the latter was likewise on its down-stroke, *i. e.*, after the compressor had taken its full complement of gas. On the up-stroke of the compressor-piston the gas and oil were discharged through the large valve of the dome, the oil following the gas after the latter had passed out of the compressor, both being heated in consequence of the compression of the gas. Under the increased pressure of compression a certain amount of ammonia gas was absorbed by

* From the Laboratory of the De La Vergne Refrigerating Machine Co.

the oil present over the piston. The oil thus charged with gas and after leaving the dome of the compressor was dropped into a separator, the so-called pressure tank, where it collected at the bottom. From here it passed through an oil-cooling coil and was collected at the bottom of the before-mentioned low-pressure oil tank, and being there exposed again to the suction-pressure of the machine, lost the identical amount of gas which it had previously absorbed during the compression period in the compressor. This amount of gas passed off into the suction-pipe of the gas-pump without doing any efficient cooling work, and therefore represented a certain loss in the efficiency of the compressor, which to ascertain was the object of my experiments.

To solve the question it was necessary to first make a series of tests as to the amount of ammonia, which the oil (or liquid base as it has been termed by the De La Vergne Company) could hold in solution under different pressures and temperatures. Though it is generally believed that the quantity of gas absorbed by a liquid (the temperature remaining the same) is proportional to the absolute prevailing pressure, it will be seen at a later place of this paper, that this law does not hold good as strictly as is generally believed. Therefore, it is always necessary to ascertain by tests, whether or not a gas follows this law. Thus the amount of ammonia which the liquid base could hold in solution under different pressures and temperatures being known, and the pressure and temperature of the oil in the low-pressure oil tank as well as in the high-pressure oil tank being likewise known, the amount of ammonia contained in one charge of oil can be found by calculation, first when this oil is injected into the compressor, and second when it leaves the compressor. The difference between the two quantities of ammonia represents the loss during each stroke of the compressor, and the number of cubic inches occupied by this ammonia under suction-pressure, and the cubical contents of the compressor being known, the ratio of the two volumes will represent the percentage of loss.

To illustrate this by an example, let us assume a single-acting compressor of 12 inches diameter and 24 inches

stroke, the contents of which are equal to 2,714 cubic inches. It is the practice of the De La Vergne Company to inject into this compressor thirty-five cubic inches of liquid base, at each down-stroke.

Now let us assume:

A condensing pressure of 146·7 pounds absolute, temperature 150° F.
A back pressure of 44 " " " 70° F.

According to Table V:

	Volumes.
1 volume of liquid base absorbs at 146·7 lbs. absolute pressure and 150°,	12·430
1 " " " 44 " " " " 70°,	6·599

both volumes reduced to normal pressure (14·67 pounds) and 32° F.

One volume of oil therefore loses, if reduced from 146·7 pounds and 150° to forty-four pounds and 70°: 12·430 — 6·599 = 5·831 volumes of ammonia at normal pressure and 32°; and if subjected to a pressure of forty-four pounds and a temperature of 70° these 5·831 volumes will occupy only 2·09 volumes. Consequently the ammonia which is allowed to escape out of the thirty-five cubic inches of oil injected, occupies 73·15 cubic inches under pressure and temperature of the suction-side of the compressor; and the contents of the latter being 2,714 cubic inches, 2·69 per cent. is the loss in efficiency of this compressor.

In the new system of oil-circulation in the De La Vergne compressor even this small item of loss is entirely obviated, because the oil is now injected under pressure into the compressor after the same has taken in its full supply of gas.

The oil or liquid base used in the De La Vergne machine is a mineral oil, because all vegetable and animal oils saponify in connection with ammonia.

In distilling this oil in fractions the result is as follows:

	Per Cent.
Volatile bodies, distilling over at 464° to 500° F.	0·5
500° to 536° F.	0·7
536° to 572° F.	0·4
above 572° F.	92·2
Non-volatile residue, ...	6·2
	100·0

The flashing point is at 380°, the congealing point at 6°, the specific heat is 0·4618.

TABLE I.—SHOWING THE SPECIFIC GRAVITIES OF LIQUID BASE AT TEMPERATURES FROM 50° TO 280° F.

Temperature.	Spec. Grav.	Temperature.	Spec. Grav.	Temperature.	Spec. Grav.
50	0·9115	130	0·8847	210	0·8575
60	0·9069	140	0·8812	220	0·8538
70	0·9057	150	0·8778	230	0·8501
80	0·9037	160	0·8744	240	0·8464
90	0·8991	170	0·8711	250	0·8427
100	0·8952	180	0·8674	260	0·8390
110	0·8915	190	0·8648	270	0·8353
120	0·8881	200	0·8612	280	0·8316

While perusing the literature on ammonia, I found some data which I think are not as generally known as they ought to be and which I, therefore, give in the following. Determination of the quantities of ammonia, which are absorbed by water at atmospheric pressure, have been made by Sims, Bunsen, Roscoe and Schorlemer (cf. *Ann. d. Chem. and Pharm.* 117, 118). I give the figures obtained by them in Table II, a graphic representation in *Fig. 2.* It will be seen that the figures obtained by these scientists differ more or less from one another, and the rather surprising fact will appear that even at 212° ninety-seven volumes of ammonia gas are still absorbed by water.

Determinations of the quantities of ammonia which are absorbed by water at different pressures, have been made by Sims (*ibid.*). I give the figures obtained by him in Table III. In *Fig. 3,* I give a graphic representation, the full lines showing how the absorption of ammonia by water in reality takes place according to Sims' tests; the dotted lines showing how the absorption ought to take place according to the above-mentioned law, if we take the figures of Sims, Bunsen, Roscoe and Schorlemer, respectively, as the true figures of the quantities of ammonia absorbed by water at 32°, 68°, 104° and 212°, respectively, and atmospheric pressure. It will be seen that the two lines only coincide at 212°, at the

lower temperatures the amount of ammonia absorbed being more or less smaller than it ought to be.

TABLE II.—SHOWING THE ABSORPTION OF AMMONIA BY WATER AT DIFFERENT TEMPERATURES AND ATMOSPHERIC PRESSURE, ACCORDING TO DIFF-ER ENT AUTHORS.

One Volume of Water absorbs the Following Quantities of Ammonia :

	Sims.		Bunsen.		Roscoe & Dittmar.			Sims.		Bunsen.		Roscoe & Dittmar.	
° F.	Grammes.	Volumes.	Grammes.	Volumes.	Grammes.	Volumes.	° F.	Grammes.	Volumes.	Grammes.	Volumes.	Grammes.	Volumes.
32·0	0·899	1,180	0·799	1,050	0·875	1,150	125·6	0·274	359	—	—	0·214	281
35·6	0·853	1,120	0·756	993	0·833	1,094	129·2	0·265	348	—	—	0·200	262
39·2	0·809	1,062	0·717	942	0·792	1,040	132·8	0·256	336	—	—	0·185	239
42·8	0·765	1,005	0·681	895	0·751	986	136·4	0·247	324				
46·4	0·724	951	0·649	852	0·713	936	140·0	0·238	312				
50·0	0·684	898	0·618	813	0·679	892	143·6	0·229	301				
53·6	0·646	848	0·592	777	0·645	847	147·2	0·220	289				
57·2	0·611	802	0·566	743	0·612	803	150·8	0·211	277				
60·8	0·578	759	0·542	712	0·582	764	154·4	0·202	265				
64·4	0·546	717	0·519	682	0·554	728	158·0	0·194	254				
68·0	0·518	683	0·498	654	0·526	691	161·6	0·186	244				
71·6	0·490	643	—	—	0·499	655	165·2	0·178	234				
75·2	0·467	613	—	—	0·474	622	168·8	0·170	223				
78·8	0·446	585	—	—	0·449	589	172·4	0·162	212				
82·4	0·426	559	—	—	0·426	559	176·0	0·154	202				
86·0	0·408	536	—	—	0·403	529	179·6	0·146	192				
89·2	0·393	516	—	—	0·382	502	183·2	0·138	181				
93·2	0·378	496	—	—	0·362	475	186·8	0·130	170				
96·8	0·363	478	—	—	0·343	450	190·4	0·122	160				
100·4	0·350	459	—	—	0·324	425	194·0	0·114	149				
104·0	0·338	444	—	—	0·307	403	197·6	0·106	139				
107·6	0·326	428	—	—	0·290	381	201·2	0·098	128				
111·2	0·315	414	—	—	0·275	361	204·8	0·090	118				
114·8	0·304	399	—	—	0·259	340	208·4	0·082	107				
118·4	0·294	386	—	—	0·244	321	212·0	0·074	97				
122·0	0·284	373	—	—	0·229	301							

In Table IV, I give the figures showing the quantities of ammonia absorbed by liquid base at temperatures from

32° to 300° and atmospheric pressure; *Fig. 4* shows the graphic representation of the same. In Table V, I give the figures, and in *Fig. 5*, the graphic representation, according to which the absorption of ammonia by liquid base takes place at temperatures of 32°, 70° and 150°, and absolute

TABLE III.—SHOWING THE ABSORPTION OF AMMONIA BY WATER AT DIFFERENT TEMPERATURES AND PRESSURES, ACCORDING TO SIMS.

One Volume of Water absorbs the Following Quantities of Ammonia:

Absolute Pressure in Pounds per Square Inch.	32° F.		68° F.		104° F.		212° F.	
	Grammes.	Volumes.	Grammes.	Volumes.	Grammes.	Volumes.	Grammes.	Volumes.
14·67	0·899	1,180	0·518	683	0·338	443	0·074	97
15·44	0·937	1,231	0·535	703	0·349	458	0·078	102
16·41	0·980	1,287	0·556	730	0·363	476	0·083	109
17·37	1·029	1,351	0·574	754	0·378	496	0·088	115
18·34	1·077	1,414	0·594	781	0·391	513	0·092	120
19·30	1·126	1,478	0·613	805	0.404	531	0·096	126
20·27	1·177	1,546	0·632	830	0·414	543	0·101	132
21·23	1·230	1,615	0·651	855	0·425	558	0·106	139
22·19	1·283	1,685	0·669	878	0·434	570	0·110	140
23·16	1·336	1,754	0·685	894	0·445	584	0·115	151
24·13	1·388	1,823	0·704	924	0·454	596	0·120	157
25·09	1·442	1,894	0·722	948	0·463	609	0·125	164
26·06	1·496	1,965	0·741	973	0·472	619	0.130	170
27·02	1·549	2,034	0·761	999	0·479	629	0·135	177
27·99	1·603	2,105	0·780	1,023	0·486	638	—	—
28·95	1·656	2,175	0·801	1,052	0·493	647	—	—
30·88	1·758	2,309	0·842	1,106	0·511	671	—	—
32·81	1·861	2,444	0·881	1,157	0·530	696	—	—
34·74	1·966	2,582	0·919	1,207	0·547	718	—	—
36·67	2·070	2,718	0·955	1,254	0·565	742	—	—
38·60	—	—	0·992	1,302	0·579	764	—	—
40·53	—	—	—	—	0·594	780	—	—

pressures from one to four atmospheres, the full lines showing the amount of ammonia in reality absorbed, the dotted lines showing the amount which ought to be absorbed. It will be seen that, contrary to the absorption of ammonia by water, the absorption of ammonia by liquid base is

according to the above-mentioned law, the differences existing between the two lines of 70° and 150° being due to error of observation. At 32° the absorption seemingly does not follow at all the law for the absorption of gases, the full line diverging upwards of about two and one-quarter atmospheres more and more from the dotted line. But this is only due to the fact that the ammonia comes nearer and nearer the point where it liquefies (the liquefying point of ammonia at 32° taking place at an absolute pressure of

TABLE IV.—SHOWING THE ABSORPTION OF AMMONIA BY LIQUID BASE AT DIFFERENT TEMPERATURES AND ATMOSPHERIC PRESSURE.

Temperature in ° F.	1 Vol. of Liquid Base absorbs Volumes of Ammonia, Calculated at 32° and Normal Pressure.	Temperature in ° F.	1 Vol. of Liquid Base absorbs Volumes of Ammonia, Calculated at 32° and Normal Pressure.
	volumes.		*volumes.*
32	3·139	150	1·243
40	2·880	160	1·117
	2·592	170	1·012
60	2·383	190	0·898
70	2·197	210	0·873
0	2·091	232	0·751
90	1·950	250	0·700
100	1·824	260	0·680
110	1·714	270	0·661
120	1·588	283	0·638
130	1·465	300	0·611
140	1·308		

4·215 atmospheres or 61·834 pounds), and the amount of any gas absorbed by a liquid always exceeds the amount which ought to be absorbed, as soon as the temperature of the gas comes near its liquefying point.

The tests were made in the following manner:

Flask *A B C* (see *Fig. 1*) that is to be filled with liquid base is made of strong glass. It contains up to the beginning of its neck 555 ccm., the neck itself which is divided into cubic centimetres, contains 45 ccm., the whole contents of the flask thus being 600 ccm. It is filled with liquid base

by means of a siphon to such an extent that afterwards, if heated up to the temperature at which the test is to take place, the liquid base reaches to the lower part of the graduated neck. Flask *A B C* is put on a support in the covered sheet-iron tank *D E F G*, which is filled with linseed-oil or water and can be heated up by means of the burners *H H*

TABLE V.—SHOWING THE ABSORPTION OF AMMONIA BY LIQUID BASE AT DIFFERENT TEMPERATURES AND PRESSURES.

Absolute Pressure Expressed in Pounds per Square Inch.	1 Vol. of Liquid Base absorbs Volumes of Ammonia, Calculated at 32° and Normal Pressure.					
	at 32° F.		at 70° F.		at 150° F.	
	Volumes of Ammonia in Reality Absorbed.	Volumes which ought to be Absorbed.	Volumes of Ammonia in Reality Absorbed.	Volumes which ought to be Absorbed.	Volumes of Ammonia in Reality Absorbed.	Volumes which ought to be Absorbed.
14·67	3·139	—	2·197	—	1·243	—
18·34	3·862	3·924	2·862	2·746	1·477	1·554
22·00	4·914	4·708	3·399	3·295	1·811	1 864
25·67	5·677	5·493	3·946	3·845	2·053	2·175
29·34	6·333	6·278	4·442	4·394	2·387	2·486
33·01	7·354	7·063	5·041	4·943	2·671	2·797
36·67	8·039	7·847	5·657	5·492	2·959	3·107
40·34	8·933	8·632	6·219	6·042	3·247	3·418
44·01	10·046	9.417	6·599	6·591	3·556	3·729
47·68	10·990	10·201	7·344	7·140	3·841	4·039
51·34	12·338	10·986	7·724	7·692	4·169	4·350
55·01	13·427	11·771	8·352	8·239	4·467	4·661
58·68	15·655	12·566	8·529	8·788	4·692	4·972
146·70		calculated.				12·430

to any desired temperature, controlled by the thermometer *I* and kept uniform in all parts by means of the agitator *K*. The pipe *a b c* is capillary, the diameter of the pipes *d e f* and *e g* four mm. inside. Cocks *v* and *u* are common stop-cocks, cock *g* the plug of which has a wedge-shaped perforation; allows to regulate the quantity of ammonia escaping out of the flask *A B C* in the minutest manner. From *g* the escaping

gas passes through a stratum of mineral oil in *D'*, and from there into the atmosphere. The purpose this bottle *D'* is intended for is that by the velocity with which the bubbles of ammonia pass through the oil in *D'*, the velocity of the current of ammonia passing through flask *A B C* can be judged. The pipe ends *a* and *f* are provided with bulbs and by means of strong pieces of rubber-hose (the resistance of which is strengthened by brass-sheathings wrapped over them) connected with two short pieces of iron pipe which are provided on their other ends *h* and *i* with a thread and a nut, fitting the nut *k* and the thread *l*, respectively, tightly by means of washers. The nut *k* is at the end of the pipe *k o* terminating into the top of tank *P Q* which is filled with pieces of sodium hydrate. The ammonia developed in tank *R S* passes through the contents of tank *P Q*, and is thus freed of any moisture which may be present. In order to make the development of the ammonia constant and thus avoid as much as possible any sudden turbulent eruptions of the same, tank *R S* is put in cold water contained in tank *T U*. Cock *p* is of such a construction as to allow us to regulate the quantity of ammonia entering flask *A B C* in the minutest manner. The other end of the iron pipe *l m* by means of a strong piece of rubber-hose (again strengthened by brass-sheathing) is connected with the end *n* of the mercury gauge *L M N O*. Pipes *L M* and *N O* being about two and one-half metres long, an absolute pressure of four atmospheres can be obtained without having the mercury in leg *L M* go too far down to the bend *M*, and thus without being exposed to the liability of one of the above-mentioned uncontrollable eruptions of the ammonia forcing the mercury entirely out of leg *L M*, and thus spoiling the whole test. Pipe *L M* being capillary, the diameter of *N O* being five mm. inside, an oscillation of a few millimetres up or down of the mercury in *L M* is hardly noticeable in *O N*, and thus by regulating cocks *p* and *g* the pressure prevailing during the test can be kept constant within a few millimetres.

When the contents of flask *A B C* have the desired temperature, the whole apparatus is put together as shown in

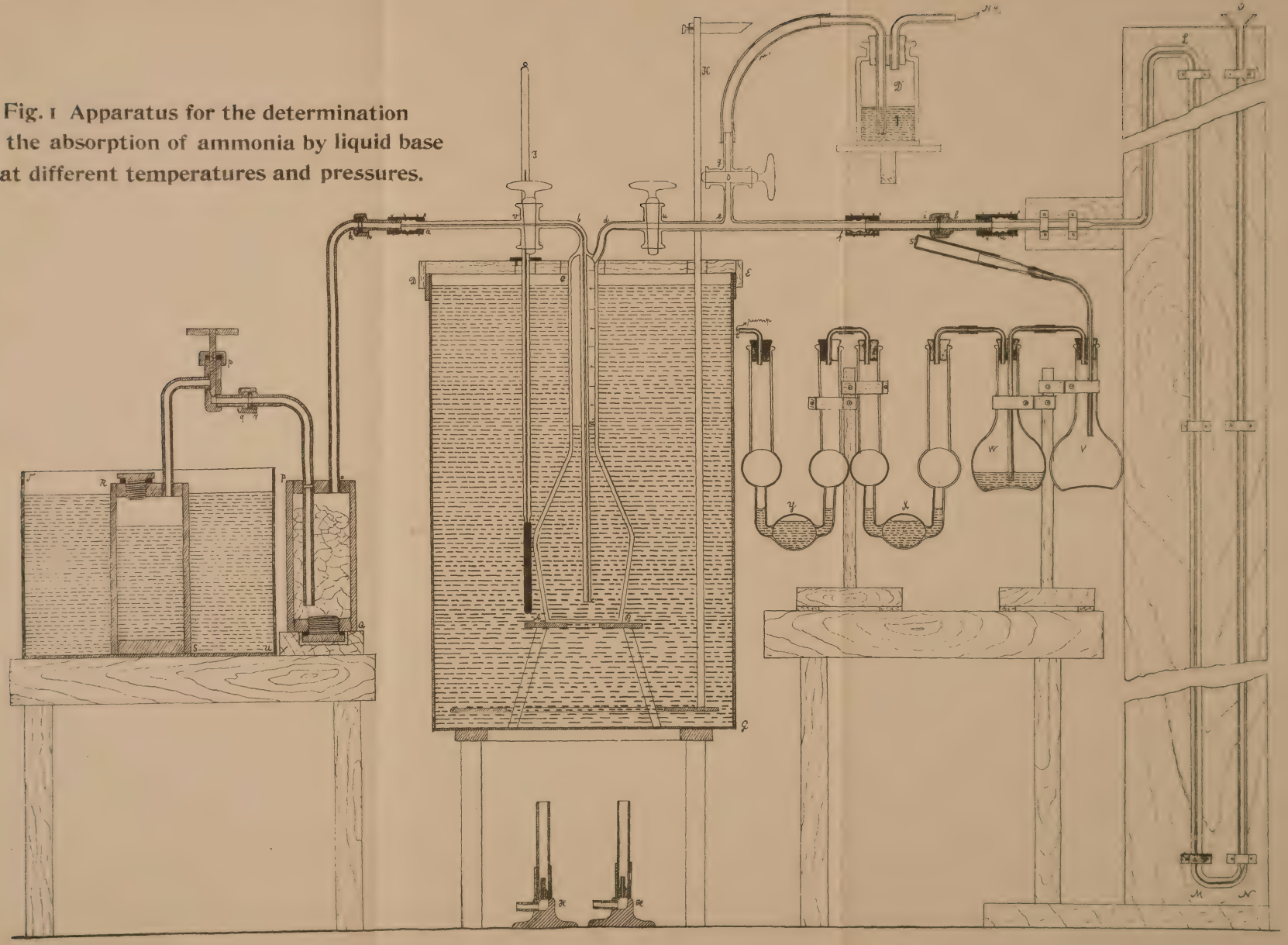


Fig. 1 Apparatus for the determination of the absorption of ammonia by liquid base at different temperatures and pressures.

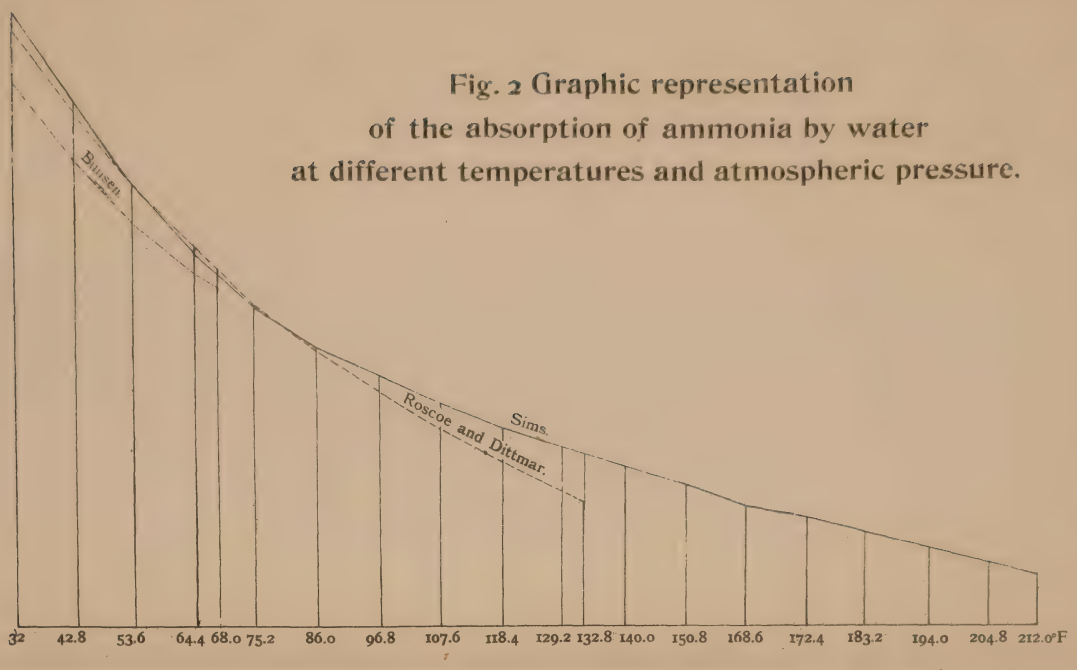
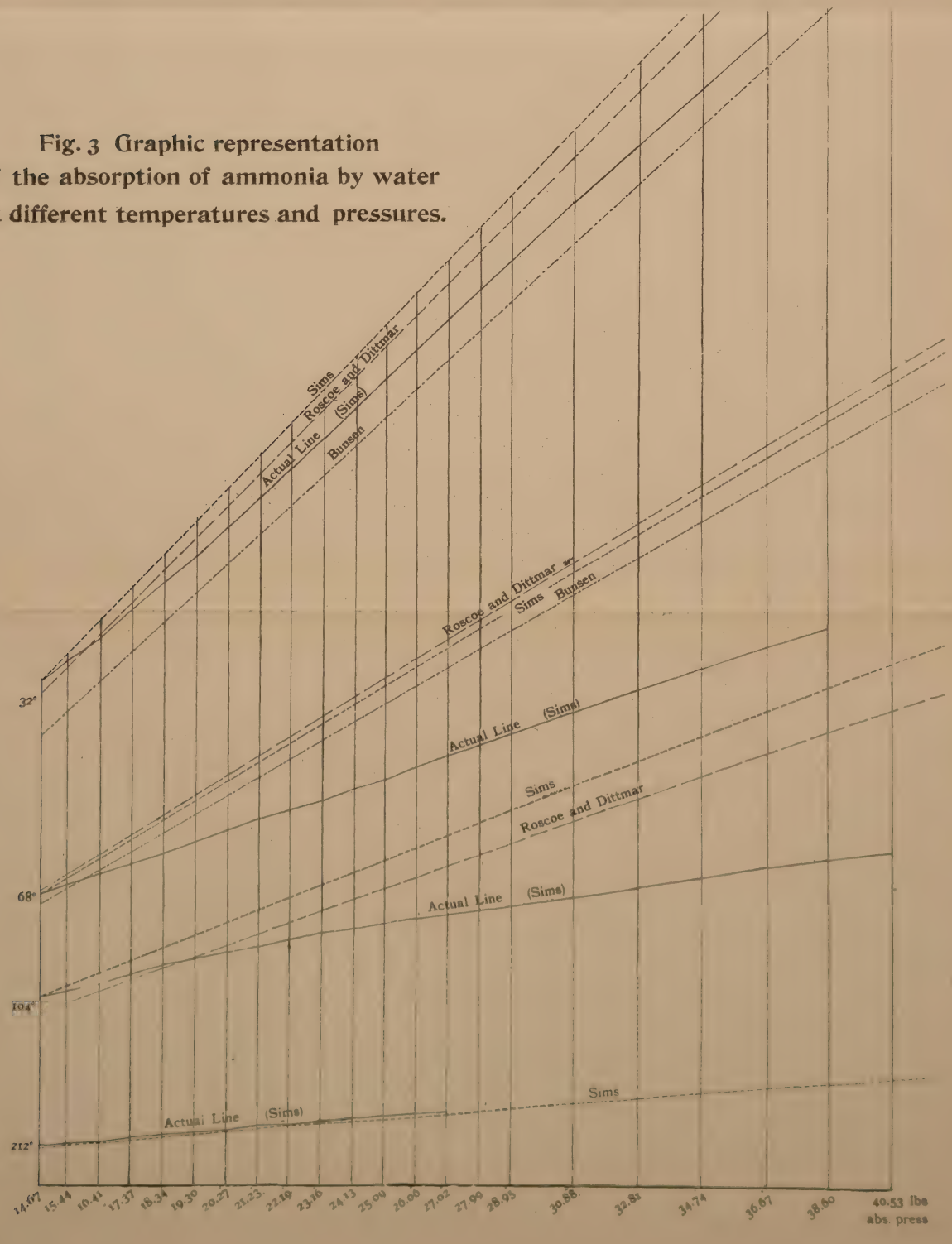


Fig. 2 Graphic representation of the absorption of ammonia by water at different temperatures and atmospheric pressure.

Fig. 3 Graphic representation of the absorption of ammonia by water at different temperatures and pressures.



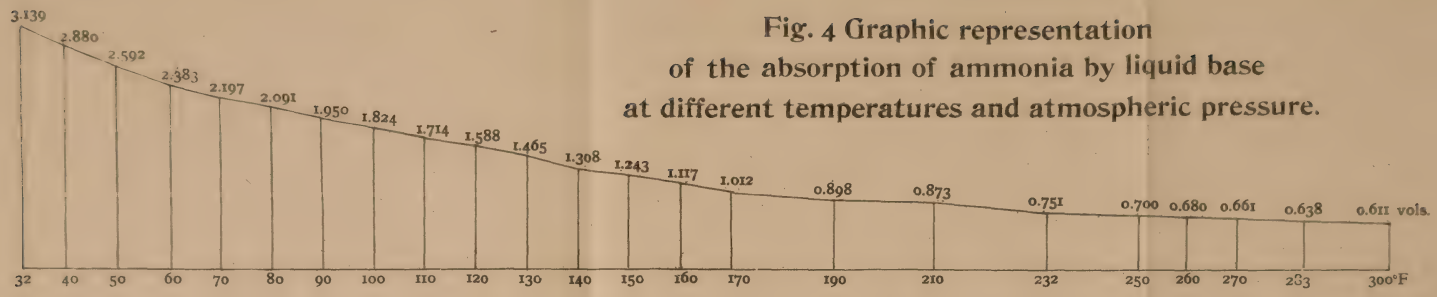


Fig. 4 Graphic representation of the absorption of ammonia by liquid base at different temperatures and atmospheric pressure.

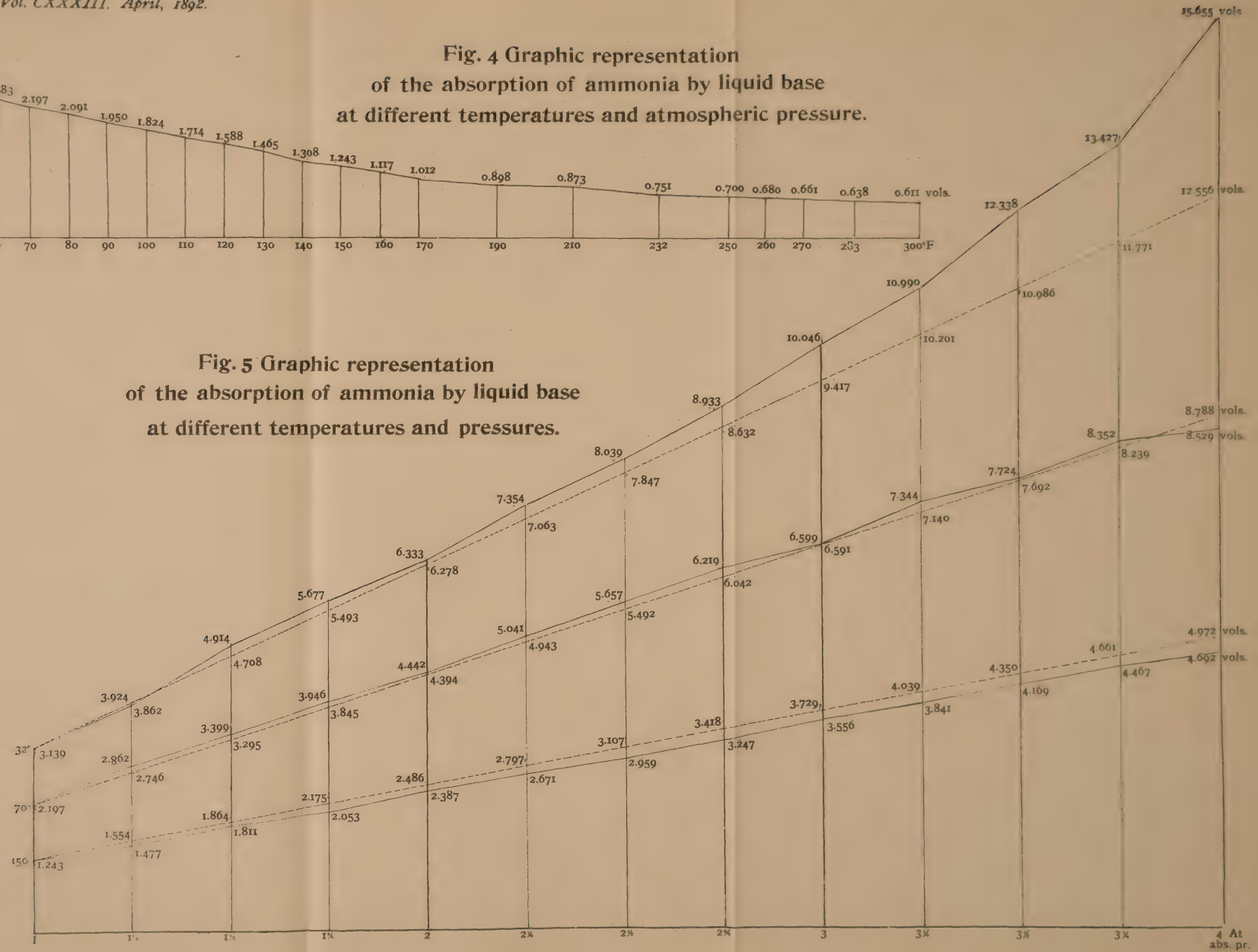


Fig. 5 Graphic representation of the absorption of ammonia by liquid base at different temperatures and pressures.

Fig. 1. Ammonia is allowed to pass through the oil until all air in the neck of *A B C*, in bottle *D'* and in the gauge, is displaced by ammonia, and then mercury filled into the gauge to a convenient height. If the test is to be made at atmospheric pressure, nothing is to be done but to regulate the current of ammonia in such a way that the mercury column is at the same height in both legs of the gauge, but the pipe *d e g* having a much larger diameter than *a b c*, hardly any regulation of cock *p* is necessary. If the test is to be made at higher pressure the two cocks *p* and *g* are handled until the pressure indicated by the gauge is the desired one, it being taken care that a properly strong current of ammonia escapes through *D'*. According to the prevailing temperature and pressure it takes from one-half to two hours, until the liquid base is entirely saturated with ammonia. This condition being obtained, cocks *u* and *v* are closed in the very same moment, and *k* is disconnected from *h*. Then *i* having been disconnected from *l* and by means of the rubber-hose *s* having been connected to the absorbing apparatus, cock *u* is opened. As soon as the first turbulent escaping of ammonia is over, cock *v* is opened and a slow current of pure air is conducted through the whole apparatus, the linseed-oil in tank *D E F G* being heated up during this time at about 300°. Thus all ammonia that was absorbed by liquid base is conducted into the absorbing apparatus, where it is transformed into ammonium chloride, *W X* and *Y* being filled with diluted muriatic acid. If the test has been made at higher pressure and the absorbed ammonia is drawn off, larger or smaller quantities of liquid base are always forced out of flask *A B C*, and these are retained in the empty bottle *V*, thus not interfering with the formation of pure ammonium chloride in *W X* and *Y*. It takes about three hours until the last traces of ammonia are obtained in the receivers. The weight of the ammonia which had been absorbed by the oil and from it the volume of the same calculated at 32° and normal pressure, is determined in the usual way. From the volume thus obtained the volume of ammonia which at the end of the test was above the liquid base in the graduated neck of flask *A B C*,

is to be subtracted. As it is under the pressure and temperature, at which the test was made, its volume at 32° and normal pressure is to be calculated. Then by dividing the cubic centimetres of ammonia really absorbed by the oil, by the cubic centimetres of liquid base used in the test, the volume of ammonia absorbed by the unit of liquid base is obtained. For mechanical reasons, it is practically impossible to keep the pressure exactly at the point at which the test was intended to be made, and the absorption took place at a pressure of a few millimetres more or less in almost all tests made. From the results obtained with the pressures prevailing we obtain the figures for the pressures intended by application of the above-cited law for the absorption of gases by liquids at different pressures. The following is an example how this calculation was made:

Temperature at which the test was made, 150°; absolute pressure prevailing, 1906·0 mm.; absolute pressure intended, 1900·0 mm. = 2½ atmospheres; volume of liquid base used in the test, 559·0 ccm. at 150°. Consequently at the end of the test 600 — 559 = 41·0 ccm. of ammonia at 1906·0 mm., absolute pressure, and 150° are above the oil. These are equal to 82·7 ccm. at 32° and normal pressure.

The weight of ammonium chloride yielded is 4·2050 grammes = 1·3360 grammes = 1754·6 ccm. of ammonia at 32° and normal pressure. The 82·7 ccm. of ammonia abovementioned being subtracted, 1754·6 — 82·7 = 1671·9 ccm. of ammonia were in reality absorbed by the 559·0 ccm. of liquid base or 2·990 volumes by the unit. If 2·990 volumes are absorbed at 1906·0 mm.,

$$\frac{2{\cdot}990 \times 1900{\cdot}0}{1906{\cdot}0} = 2{\cdot}981 \text{ volumes}$$

are absorbed at an absolute pressure of 1900·0 mm.

By calculations based on the above data, Mr. A. Siebert, Superintending Engineer of the De La Vergne Refrigerating Machine Company, found that the volumes of ammonia absorbed at temperatures between 80° and 300° F. can approximately be calculated by the formula:

$$d = 3{\cdot}139 - 0{\cdot}023972\ (t - 32°) + 0{\cdot}0000807\,3\ (t - 32°)^2 - 0{\cdot}0000000988\ (t - 32°)^3$$

PROCEEDINGS.

[*Stated meeting held Tuesday, April 19, 1892.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, April 19, 1892.

Dr. Wm. H. Wahl, President, in the chair.

Professor Henry Trimble read a paper on "Chestnut-bark Tannin." This paper gives the results of an investigation which forms the second and final part of a research to determine whether any differences exist between the tannin extracted from the wood of the tree on the one hand and the bark on the other. The results of the investigation of the tannin from the wood have already been published by Prof. Trimble in a former paper read before the Section. The results formed a subject of a brief discussion, and the paper was submitted for publication in the *Journal*.

A sample of the tannin was exhibited by the author.

A brief communication from Mr. Chas. E. Ronaldson, M.E., on "The Influence of Bottles upon Wines," was read and discussed by the Section. The same related principally to the progress made in the United States by glass manufacturers in producing glass of proper composition for the purpose named.

The Section then adjourned. WM. C. DAY, *Secretary*.

CHESTNUT-BARK TANNIN.

BY HENRY TRIMBLE.

[*Read at stated meeting of the Section, held Tuesday, April 19, 1892.*]

In the manufacture of chestnut extract the bark and wood are used together, the latter naturally exceeding the former in amount, as well as in yield of extract.

It has been thought desirable to determine if there exists any differences in the character of the tannins from these two parts of the tree, and the results of an investigation of that from the wood were published in this *Journal*, **132**, p. 303.

The material in this case was obtained from a tree thirty years old, cut in August; the bark was immediately removed, air dried and powdered.

The total tannin was found to be 7·31 per cent. The

wood yielded 7·85 per cent. The other important constituents in the bark were found to be in per cent., 1·09 of resin, 3·06 of mucilage, 1·35 of glucose, 10·00 of moisture, 4·71 of ash and 45·44 of cellulose.

The tannin, as extracted by commercial ether, was much darker in color than that similarly prepared from the wood, but an equally light-colored product was obtained by first precipitating in fractions with lead acetate, and then further treating the middle and most abundant one with salt and acetic ether. The aqueous solution of this portion, after removal of lead by hydrogen sulphide, when saturated with common salt, separated a dark-colored portion which rose to the top, and was easily removed in one mass after standing twenty-four hours. The remaining light-colored solution was agitated with acetic ether, the latter separated, and, after removal of the solvent under reduced pressure, a light-colored product was obtained. This was then dissolved in water, filtered and the solvent distilled off under reduced pressure; it was then dissolved in ether, filtered and again dried in a vacuum at the temperature of a boil ing water-bath.

The product was a light, almost white, porous mass of a reddish-brown shade, which was completely and readily soluble in water and the other usual solvents, and in all other respects corresponded with the chestnut-wood tannin described in the previous paper, as well as with gallotannic acid. It did not give any reaction for glucose, from which compound it was rather more easily purified than the product from the wood.

The average of two closely-agreeing combustions gave the following percentages, with which are given those from the tannin of the wood, for comparison:

	Chestnut-bark Tannin.	*Chestnut-wood Tannin.*
C,	52·42	52·11
H,	4·67	4·40
O,	42·91	43·49
	100 00	100·00

The conclusions to be drawn from this work are that the

tannins from chestnut bark and wood are identical, and, although ultimate analyses show high percentages of hydrogen in both, they are believed to be identical with gallotannic acid.

In an investigation of the darker tannin precipitated from aqueous solution by salt, the following percentages were obtained:

C,	55·18
H,	4·72
O,	40·10
	100·00

This product was considered to be a mixture of the tannin with its anhydride.

PROCEEDINGS.

[*Stated meeting, held Tuesday, May 17, 1892.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, May 17, 1892.

Dr. Wm. H. Wahl, President, in the chair.

A paper on "An Improved Method of Determining Small Percentages of Gold and Silver in Base Metal," by Mr. Cabell Whitehead, of Washington, D. C., was read by Dr. D. K. Tuttle. It was followed by an interesting discussion.

The paper was referred for publication in the *Journal.*

Mr. F. Lynwood Garrison then gave a number of views of the recently conducted armor-plate tests at Indian Head proving ground. Mr. Garrison discussed the results of these tests from the metallurgical standpoint. The complete report of Mr. Garrison to the Institute will appear in the *Journal.*

Adjourned. WM. C. DAY, *Secretary.*

An Improved Method of Determining Small Percentages of Silver and Gold in Base Metals, Mattes, etc.

By Cabell Whitehead,
Assayer to the Mint Bureau, Washington, D. C.

[*Read at the stated meeting held May 17, 1892.*]

Any one having frequent occasion to report the values of silver and gold in such material as crude copper, copper mattes or ores, metallic iron, zinc, etc., will appreciate the advantages of a method which affords accurate results with little expenditure of time. The large production of pure copper by electrolytic methods from silver- and gold-bearing copper ores, renders some such method very desirable in view of the various transfers of, (1), ores to the smelters; (2), mattes to the refiners; and last, the crude copper to the electrolytic refinery, each of which transfers carries a commercial charge of the bullion contents.

While the proposed method is available for a great variety of base products, it will perhaps best be illustrated by its use in determining the silver and gold contents in crude copper or the mattes resulting from bullion-bearing copper ores. The adaptability of the method to other base metals will readily suggest itself to the experienced assayer.

Given a crude copper or matte carrying from thirty ounces of silver and ·10 of an ounce of gold, upward, the usual method would be scorification. It is usual to take for assay from ·05 to ·1 assay ton to each scorifier, with which are used from forty to fifty grammes of test lead, one-half of which is mixed with the ore in the scorifier and the remainder used as a cover. The scorifier is now introduced into a hot muffle and the door closed until the lead is melted, when it is opened and about one gramme of borax glass placed on the lead. Oxidation begins at once and the lead and base metals are rapidly scorified off until the slag covers the metal, when the assay is poured into a mould. If the lead

button still retains much copper, or is hard or brittle, it is again scorified, with the addition of more test lead if necessary. When the lead button is soft and of proper size, it is cupelled and the button weighed and parted. Several scorifications are sometimes necessary before the button is ready for the cupel.

The two objections to this method are, first, the loss of silver during scorification and cupellation, the latter due chiefly to the copper remaining in the lead which it is practically impossible to remove in the scorifier, and which takes silver into the cupel. These losses I found to amount to from 2·33 to 2·78 per cent. of the silver present in the copper. My experiments were made with pure copper and pure silver, the silver being added in the proportion of 100 ounces per ton of alloy.

The second objection is the small amount of bullion which can be operated upon, which necessitates the use of many scorifiers where small amounts of gold are to be estimated, which is usually the case.

To avoid the doubtful results of scorification processes, the following method has been adopted at the copper works of a firm having large interests at stake:

One assay ton of copper is dissolved in nitric acid, diluted and allowed twenty-four hours to settle. The solution is now filtered from the slight sediment containing the gold. A few drops of hydrochloric acid are added to the filtrate and the solution again allowed twenty-four hours for silver chloride to deposit, when it is filtered, washed and the two filters dried, combined, scorified with test lead and cupelled. The chief objections to this are, (1) the time required; (2) the small amount of precipitate obtained and the danger of loss in scorifying silver chloride; (3) the greater solubility of silver chloride as compared with the bromide.

While the method used at these works is an advance over previous practice, yet the time employed and the uncertainties indicated, leave much to be desired. The protracted time allowed for settling is necessitated by the exceedingly fine condition of the gold resulting from the solution of a metal carrying possibly from ·10 to 5 ounces

of gold per ton of metal. It would pass through a filter unless allowed to aggregate by standing.

The larger quantity (say 100 ounces) of silver per ton will give but a slowly subsiding cloud (impossible to filter) when newly precipitated as chloride. The scorification of these combined precipitates, one of them being silver chloride, cannot give results quite satisfactory, despite the time involved, some forty-eight hours at least.

The method which I will now briefly describe was devised to meet just such cases, and is suitable for the bullion valuation of zinc, iron, nickel, etc., as well as the sulphides and arsenides of iron and copper. To illustrate the proposed method, which has been found effective and useful, the treatment is detailed for a crude metallic copper carrying both silver and gold. It will be understood that sodium bromide is chosen as a precipitant because of the greater insolubility of silver bromide over the chloride, and also that the soluble lead salt is added in order that the heavy precipitate of lead bromide may envelop and promptly carry down the silver bromide cloud, which otherwise would require long waiting for its subsidence, as well as to furnish the lead necessary for cupellation.

Weigh out from one to four a. t., depending upon its richness, place it in a beaker of 500 cc. capacity and add gradually enough nitric acid to dissolve it completely, heat until red fumes cease to come off, dilute with water and add fifty grammes of lead acetate, stir, and when dissolved, add one cc. dilute sulphuric acid and allow the lead sulphate to settle. Filter into a 1,000 cc. flask and fill to the mark with distilled water.

The filter contains the gold which has been collected and carried down by the sulphate of lead. The filter paper and precipitate are dried, the paper burned and the ash and lead sulphate scorified with test lead. The button is cupelled and the gold, with any trace of silver it may contain, is weighed. Add silver and part the gold in the usual way. Note the amount, if any, of silver found and include the proper proportion of the amount with that found in the solutions as about to be described.

In order that there may be a control assay, the solution is divided into two equal parts, to each of which a saturated solution of sodium bromide is added with constant stirring as long as a precipitate is produced. The precipitates settle quickly and filter and wash well. Cold water only should be used, and the washing be continued until the washings are free from copper. Any bromide of lead dissolved during the washing, may be neglected, as I have never found it to contain more than a trace of silver, even when assaying ores carrying many thousand ounces.

The precipitate when dry can be brushed from the paper without difficulty, and thus the trouble of burning the filter is avoided. The bromides are now mixed with three times their weight of carbonate of soda and a small amount of flour or other reducing agent, placed in a small crucible, covered with borax glass and melted down in the muffle. The button should weigh about two grammes and be free from copper and other injurious impurities. This button is cupelled at a low temperature, so that the cupel "feathers" nicely. The time required is from three to five minutes. Duplicate assays usually agree within two-tenths of an ounce per ton.

The following examples are from copper bullion:

		Oz.	*Oz.*	*Oz.*
No. 1, ...	silver	61·30	61·20	gold ·10
No. 2, ...	"	63·45	63·30	" ·17

Had the gold button contained silver, one-half of its silver contents would have been added to the silver recovered from the solutions, since the gold is estimated on the whole weight, while two determinations of silver are made on the same weight.

The following is an example from a silver-bearing cast iron from the U. S. Mint at Philadelphia. It was dissolved in nitric acid, diluted and precipitated with lead and sodium bromide. After washing, the bromides were dried and brushed from the filter. No. 1 was mixed with ten grammes of litharge, a little flour, the usual amount of soda and covered with borax. Melted down and cupelled, the button gave 30·80 ounces per ton. No. 2 was mixed with test lead

and borax and scorified. It gave 29·90 ounces per ton, ·90 of an ounce less than No. 1. However, this would be considered a very close agreement by the old method.

The following is an ore from Colorado, very base and with a gangue of sulphate of barium. It proved very unsatisfactory to assay by scorification, duplicates not agreeing at all. The ore was treated with nitric acid and filtered, the residue being assayed separately.

The following are my results:

	No. 1. Oz.	*No. 2. Oz.*
Residues,	32·50	35·95
Solutions,	454·90	453·30
As a total,	487·40	489·25
Difference of	1·80	

Gold was not separated in the residues. The highest assay gotten by scorification was about 467 ounces, which shows twenty ounces in favor of the new method, with a reasonably close agreement in different assays.

PROCEEDINGS.

[*Stated meeting, held Tuesday, June 21, 1892.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, June 21, 1892.

Dr. Wm. H. Wahl, President, in the chair.

Present, nine members.

In the absence of the author, the paper of the evening, "On the Composition of the Liquid Ammonia of the Trade, and how to Manufacture Liquid Ammonia of 99·995 Per Cent.," by Dr. Hans von Strombeck, of New York, was read by the Secretary.

The paper was discussed by Messrs. Bower, Hall and Terne and was referred for publication.

Adjourned.

WM. C. DAY, *Secretary.*

On the COMPOSITION of the LIQUID AMMONIA of the TRADE and how to MANUFACTURE LIQUID AMMONIA of really 99·995 PER CENT.

By Dr. Hans von Strombeck.

[*Read at the stated meeting of the Chemical Section, June 21, 1892.*]

If the liquid ammonia of the trade, which is generally labelled and advertised as chemically pure anhydrous 100 per cent., is allowed to evaporate, a yellow fluid of peculiar penetrating odor and basic reaction is left in the bottle. This residue was left by any liquid ammonia which I subjected to the test, though they had been manufactured of different raw materials and by different processes. But the quantities left by different liquid ammonias were quite different. It is necessary to connect a long spiral cooler with the bottle in which the evaporation takes place and to surround the cooler with a refrigerating mixture, as otherwise a large percentage of the yellow fluid is carried away by the evaporating ammonia. Sometimes also white needle-shaped crystals are left by the evaporating ammonia, which partly are deposited on the lower parts of the walls, partly swim on or are dissolved in the above-said fluid. These crystals consist of sesquicarbonate or hartshorn salt of ammonia $(NH_4)_2CO_3 + NH_4HCO_3$.

While this salt was present in every liquid ammonia analyzed, it did not appear in crystalline form every time. The basic reaction of the above-said yellow fluid is due to ammonia absorbed by the same. By supersaturation with dry muriatic acid, and removing the excess by quick-lime, a yellow neutral fluid is obtained. The yellow color is due to the presence of mineral (lubricant) oil. By distillation under reduced pressure, the latter can be separated out at 200 mm. pressure between 106° and 122° F., a colorless fluid being obtained in the receiver, while all the oil remains in the still. Besides by hartshorn salt of ammonia, by mineral

oil and by "colorless fluid," as I shall call it in this paper, the liquid ammonia of the trade is contaminated by moisture and mineral matter suspended, the latter consisting of sand, peroxide of iron, etc. The mineral matter of sample B contained also sulphide of iron.

I give the analyses of six samples of so-called anhydrous liquid ammonia 100 per cent., manufactured of different raw material by different processes:

	A. *per cent.*	*B.* *per cent.*	*C.* *per cent.*	*D.* *per cent.*	*E.* *per cent.*	*F.* *per cent.*
Ammonia (by difference), .	98·976	96·984	98·220	99·792	99·321	99·180
Moisture, . . .	0·040	0·024	0·079	0·078	0·010	0·032
Colorless fluid,	0·950	2·880	1·644	0·117	0·622	0·666
Hartshorn salt of ammonia,	0·030	0·099	0·049	0·004	0·043	0·087
Lubricant oil, .	0·004	0·006	0·005	0·009	0·004	0·035
Mineral matter,	traces	0·007	0·003	traces	traces	traces
	100·000	100·000	100·000	100·000	100·000	100·000

The colorless fluid was further investigated. It has a specific gravity of 0·7948 at 60° F.; it is miscible with water, burns with little luminous flame, has a specific odor reminding of alcohol and ketone. Subjected to distillation in fractions at atmospheric pressure (758 mm.), it yielded—

				Mainly consisting of
(1)	2·5 % between 136° and 153° F.	specific gravity at 60° F.	0·8048	methyl alcohol and acetone;
(2)	4·0 " 153° " 165°	" "	0·8077	methyl- and ethyl-alcohol;
(3)	14·9 " 165° " 172°	" "	0·8016	ethyl- alcohol;
(4)	78·6 " 172° " 180°	" "	0·7901	isopropyl alcohol.

The reaction for ketones was also given by fraction No. 2; traces could also be detected in fraction No. 3. The ketones present can only be acetone and methylethylketone. Besides also traces of ethers may be present.

The composition of different colorless fluids is slightly different, but if any of them or one of its fractions is brought into contact with metallic sodium, the whole mass at once congeals to a more or less reddish powder, hydrogen at the same time being evolved, according to the equation:

Fraction 1. *Fraction 2.* *Fraction 3.* *Fraction 4.*

$$(I)\ \overbrace{CH_3.OH + CH_3.CO.CH_3} + \overbrace{CH_3.OH + C_2H_5.OH} + \overbrace{C_2H_5.OH} + \overbrace{CH_3.CH.OH.CH_3} + 2Na_2 =$$

$$CH_3.ONa + CH_3.CO.CH_2Na + CH_3.ONa + C_2H_5.ONa + C_2H_5.ONa + CH_3.CH.ONa.CH_3 + 2H_2$$

As to the constitution of the sodium acetone compound which is only of theoretical interest, I refer to *Liebig's Ann. Chem., 1891, 266, 1.*

If we suppose the fractions containing two different bodies to consist of equal parts of each, and calculate the hydrogen which ought to be evolved by the decomposition of one part by weight of colorless fluid by metallic sodium, we find that 0·0179 parts by weight of hydrogen ought to be evolved. By test I found as average of four determinations that one part by weight of colorless fluid evolves 0·0166 parts by weight of hydrogen or ninety-three per cent. of the calculated quantity. Taking into consideration that the supposition on which the calculation was based is somewhat arbitrary, a better agreement can hardly be expected. As one part by weight of hydrogen requires twenty-three parts by weight of metallic sodium for its evolution, one pound of colorless fluid requires 0·38 pound of metallic sodium for its transformation into solid sodium compound.

A reaction similar to that between colorless fluid and metallic sodium takes place between the latter body and two of the other above-mentioned contaminations of liquid ammonia, viz: Moisture and hartshorn salt of ammonia according to the equations.

(II) $2H_2O. + Na_2 = 2NaOH + H_2$

and

(III) $[(NH_4)_2CO_3 + NH_4HCO_3] + 2Na_2 = 3NH_3 + 2Na_2CO_3 + 2H_2$

Based on the reactions which have been given in these three equations, I devised a process for the manufacture of liquid ammonia which on the average contains 99·995 per cent. of ammonia, 0·005 per cent. of mineral oil and nothing else (U. S. Patent 477,089), the removal of the oil being impossible because of its chemical nature. The process is as follows:

The ammonia gas which has been manufactured by one of the usual processes, and which has been already freed of the bulk of its moisture, instead of being directly drawn into the compressor, is first led through a vessel filled with molten metallic sodium. Here in this vessel the reactions

described in the above three equations take place, whereby all contaminations present are transformed into solid non-volatile bodies and remain in this vessel, only ammonia gas and the hydrogen evolved escaping out of the same. The melting point of metallic sodium being at 204° F., it can easily be kept in a molten state by return steam which circulates through a jacket surrounding the vessel with the sodium. The ammonia is better led through two such vessels so as to make sure that all metallic sodium in the first one is exhausted before it is filled anew. By suitable connections the ammonia can be made to enter either vessel first or last. From the second vessel the now perfectly pure ammonia gas is drawn into the compressor and transformed into liquid in the usual way. From this description it will be seen that the apparatus required is of the simplest kind imaginable.

I first thought to bring the ammonia gas into contact with solid metallic sodium spread out on trays. But the reaction between the ammonia and the metallic sodium only taking place as long as the surface of the latter is metallic, a somewhat complicated apparatus would have been required to meet this purpose. Knives and scoops would have had to be arranged in a drum in such a manner that the former continuously cut the metallic sodium to infinitesimally small pieces, while the latter carry them upward and drop them after they have reached an about perpendicular position, the ammonia gas thus having to pass through a constant shower of sodium with fresh metallic surfaces.

The hydrogen evolved is to be removed, as otherwise the engine working the compressor would have to perform useless work by the compression of the same. A very appropriate way to remove it is to have the purified ammonia gas and the hydrogen pass over palladium-black or palladium-gauze, each of which readily absorbs all hydrogen. Though palladium is a rather expensive article, one pound costing about $400, its expensiveness is counterbalanced by the fact that the same quantity of palladium can be used for an indefinite time. If heavily charged with hydrogen, it is only necessary to shut off by suitably arranged cocks the

communication between the pipe filled with palladium and the rest of the plant and to lead atmospheric air through this pipe, whereby the palladium-black or gauze loses all hydrogen absorbed and is ready for use again. As one volume of palladium absorbs 800 volumes of hydrogen I do not think that even for a large plant more than one-half pound of palladium is required, as in the immensely finely distributed form in which it is used a small mass obtains an immensely large surface.

Now, let us see how much the cost caused by this purification process is. Let us make this calculation for an ammonia which, manufactured in the usual way, has the following composition, viz:

	Per Cent.
Ammonia,	98·976
Moisture,	0·040
Colorless fluid,	0·950
Hartshorn salt of ammonia,	0·030
Lubricant oil,	0·004
Mineral matter,	traces

Having above stated that one pound of colorless fluid requires 0·38 pound of metallic sodium, 0·36 pound of it is here required. One pound of metallic sodium costing $1.20, the quantity required costs forty-three cents. The metallic sodium required for the removal of each one hundredth of one per cent. of moisture costing 1·6 cents and that for the removal of each one hundredth of one per cent. of hartshorn salt costing 0·7 cents, the total expense for metallic sodium is fifty-two cents per 100 pounds of liquid ammonia. But 100 pounds of the ammonia in question yielding only 98·976 pounds of chemically pure ammonia, there is a loss of 1·024 per cent. The price of one pound of liquid ammonia being about thirty-five cents, this loss is equal to thirty-six cents. Or, the total increase of the manufacturing cost for 100 pounds is eighty-eight cents. But for this slight increase of cost we obtain a liquid ammonia which contains 99·996 per cent. of ammonia instead of the 98·976 per cent. as at present, and therefore will easily command a much higher market price.

In this calculation the sodium alcoholates resulting by the action of the metallic sodium on the colorless fluid are considered to be without any commercial value. But this is not so. By addition of water to the sodium alcoholates, and distilling with return steam the whole quantity of alcohols which was present in the raw material can be regained, and by introducing its market value into the calculation, the above stated increase of manufacturing cost will be considerably lessened.

While thus by my new process at a slight increase of cost liquid ammonia of 99·995 per cent. is obtained, the refrigerating power of which, is, of course, superior to that of the present commercial liquid ammonia, and thus the liquid ammonia sold as "strictly chemically pure anhydrous 100 per cent." really is what it is represented to be, there is still another point worthy of consideration. Every one connected with the refrigerating business knows of the terrific explosions which now and then occur in refrigerating plants, and for which heretofore no plausible cause could be given. While I cannot positively say how these explosions originate, I should think that the presence of such inflammable bodies as alcohols and ketones point to where the cause for those explosions may be looked for. It is not at all necessary, or not even likely, that the alcohols, etc., in their present form cause the explosions, but after being decomposed into hydrocarbons, etc., the latter may do so. As answer to the question of how under the conditions given in a refrigerating plant, such a decomposition can take place, I would say that this can be done by the thermo-electricity developed by the ammonia condenser. The iron return bends being tightened to the iron pipes of such a condenser by means of tin solder; and, because of the current of the ammonia gas or liquid ammonia respectively through the condenser, the tin solderings on one side of the iron pipes being colder than the tin solderings on the other side of said pipes, and the end of the condenser where the liquid ammonia leaves the same, being connected by pipes with the end where the ammonia gas enters the same, all the conditions necessary for the development of thermo-

electricity are given. The electro-motive force thus developed is, of course, only very small, but in the course of time enough hydrocarbons, etc., may be generated, which after being brought to explosion, may shatter the strongest iron pipe.

I intend to try to find out by experiment whether or not this supposition of mine be correct.

On the SPECIFIC HEAT of BRINES of DIFFERENT SPECIFIC GRAVITY.*

By Dr. Hans von Strombeck.

[*Read by title.*]

If in refrigerating plants the cooling effect is not done directly by the evaporation of the liquid, almost always brine, a solution of sodium chloride (salt) in water is used for transmitting the cold generated in the expansion coils to the place where the cooling effect is wanted. In order to be able to calculate the quantity of a brine of a certain concentration which is required for transmitting the cold generated, the specific heat of the brine must be known. Since the exact values for the specific heat of brines of different specific gravities were not yet known, I determined them by a series of tests. The results showed that the figures obtained from the tests for a certain brine differs more or less from, but is always less than, the figures we obtain by calculating the specific heat of the same brine from its contents of water and sodium chloride.

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* From the Laboratory of the De La Vergne Refrigerating Machine Co.

In the following table I give the figures obtained from the tests:

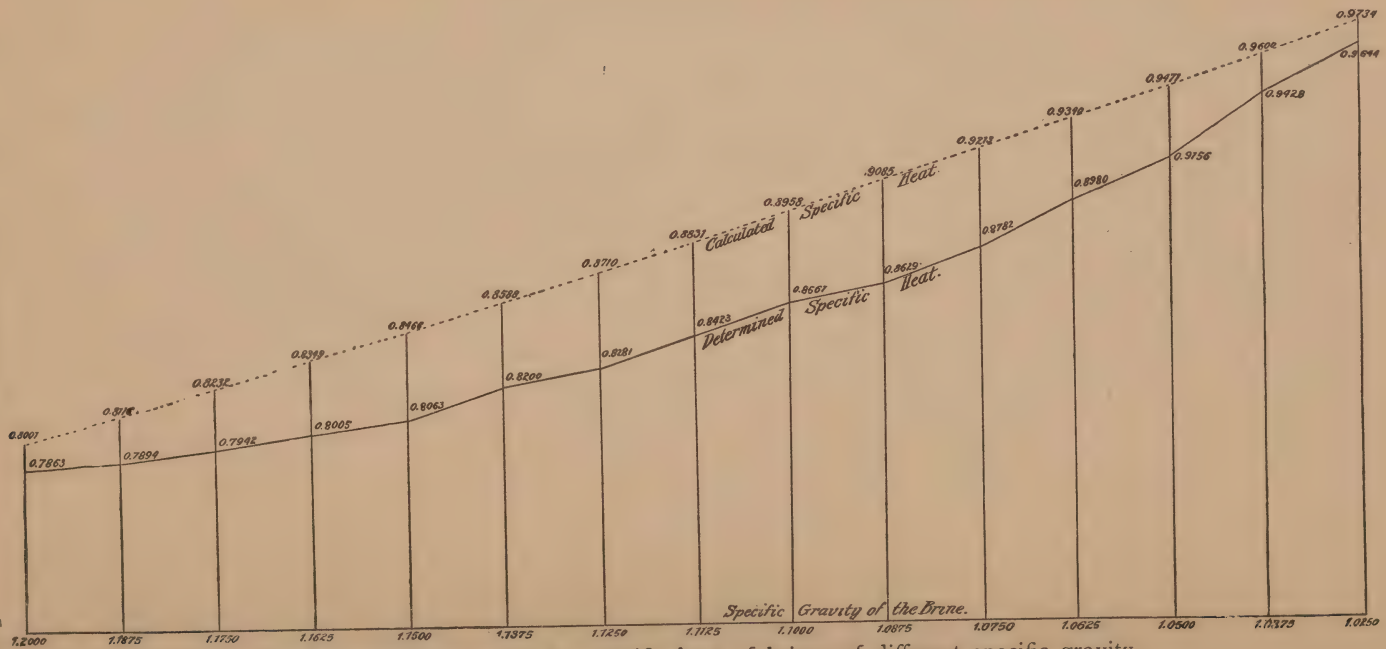
Specific Gravity of the Brine at 60° F.	The Figures in the Preceding Column being its Specific Gravity, the Brine contains Per Cent. of Salt.	Specific Heat of the Brine Calculated from its Contents of Water and Salt, the Specific Heat of the Latter taken to be 0·228.	Determined Specific Heat of the Brine, each Figure being the Average of Four Determinations well agreeing with one another.
1·0250	3·4496	0·9734	0·96440
1·0375	5·1698	0·9600	0·94284
1·0500	6·8547	0·9471	0·91561
1·0625	8·5377	0·9340	0·89798
1·0750	10·2165	0·9213	0·87819
1·0875	11·8569	0·9085	0·86295
1·1000	13·4960	0·8958	0·85610
1·1125	15·1313	0·8831	0·84233
1·1250	16·7036	0·8710	0·82810
1·1375	18·2864	0·8588	0·81998
1·1500	19·8649	0·8466	0·80631
1·1625	21·3871	0·8349	0·80050
1·1750	22·9030	0·8132	0·79417
1·1875	24·4199	0·8116	0·78936
1·2000	25·8884	0·8001	0·78633

From the graphic representation, it can still better be seen how the specific heats, calculated and determined, differ in a different degree from one another.

The tests were made in the following manner:

The apparatus* (see *Fig. 1*), which I think was first designed by Regnault, is made of brass. Tank *A B C D* is filled to such an extent with water that the end *a* of pipe *a b* dips into the water about one inch. By means of the burners *B' B''* the water in *A B C D* is kept boiling. The steam developed escapes through the pipes *F B* and *E G*, and circulates in the drum *F H I K*. In order to lessen the cooling influence of the air and the loss of heat by radiation, the drum is surrounded by a lagging, the tank and the

* I used this apparatus also for the determination of the specific heat of liquid ammonia (vol. cxxx, No. 780, of this journal) after I had made some alterations.



Graphic representation of the specific heat of brines of different specific gravity.

pipes are polished as brightly as possible. One portion of the steam developed in *A B C D* while passing the pipes and circulating in the drum is condensed and flows back to tank *A B C D*; another portion escapes through pipe *L M N O*. Pipe *L M* is enlarged into a box, into the bottom of which pipe *a b* empties, the top of it being connected with pipe *N O*. Pipe *N O* is surrounded by box *P Q R S*. This box is always kept filled with cold water from the hydrant which supplies the same at the bottom of the box, the warm water flowing out at the top. Thus the steam, while escaping through *L M N O* is condensed and through the pipe *a b* trickles down into tank *A B C D*, where it is transformed into steam again. By this arrangement steam can be developed by the same quantity of water for days without its needing to be renewed. The brass-wire basket *T* filled with brass tacks, the weight of which, both together, is known, is suspended in the middle of the cylinder *c d e f* by means of a silk thread and the plug *g*. The top of the cylinder is closed by the cover *e f*, which is tightened by a rubber ring, the bottom by the lid *c d*, which is covered on the inside by a wooden plate. It can be opened and closed by means of a thread, hook and hinges. The thermometer going through the cover, and also being tightened by a rubber ring, reaches to the top of the brass basket. The dimensions of the thermometer are taken in such a way that 0°·01 can be estimated, and that the column of mercury, when indicating the highest temperature which can be produced in *c d e f* only projects a little over the cover. Thus the temperature prevailing in the cylinder can directly be read on the thermometer, and no correction is necessary. The wooden partition *U*, which is intended to keep away from the calorimeter *h i k l*, any influence of the heat caused by the burners *B′ B″*, can be moved forwards and backwards between two posts.

The brass calorimeter *h i k l*, the weight of which is known, is filled with a weighed quantity of the brine, the specific heat of which is to be determined. It is provided with a thermometer, and the agitator *m*, by means of which the temperature of the brine is equalized in all parts.

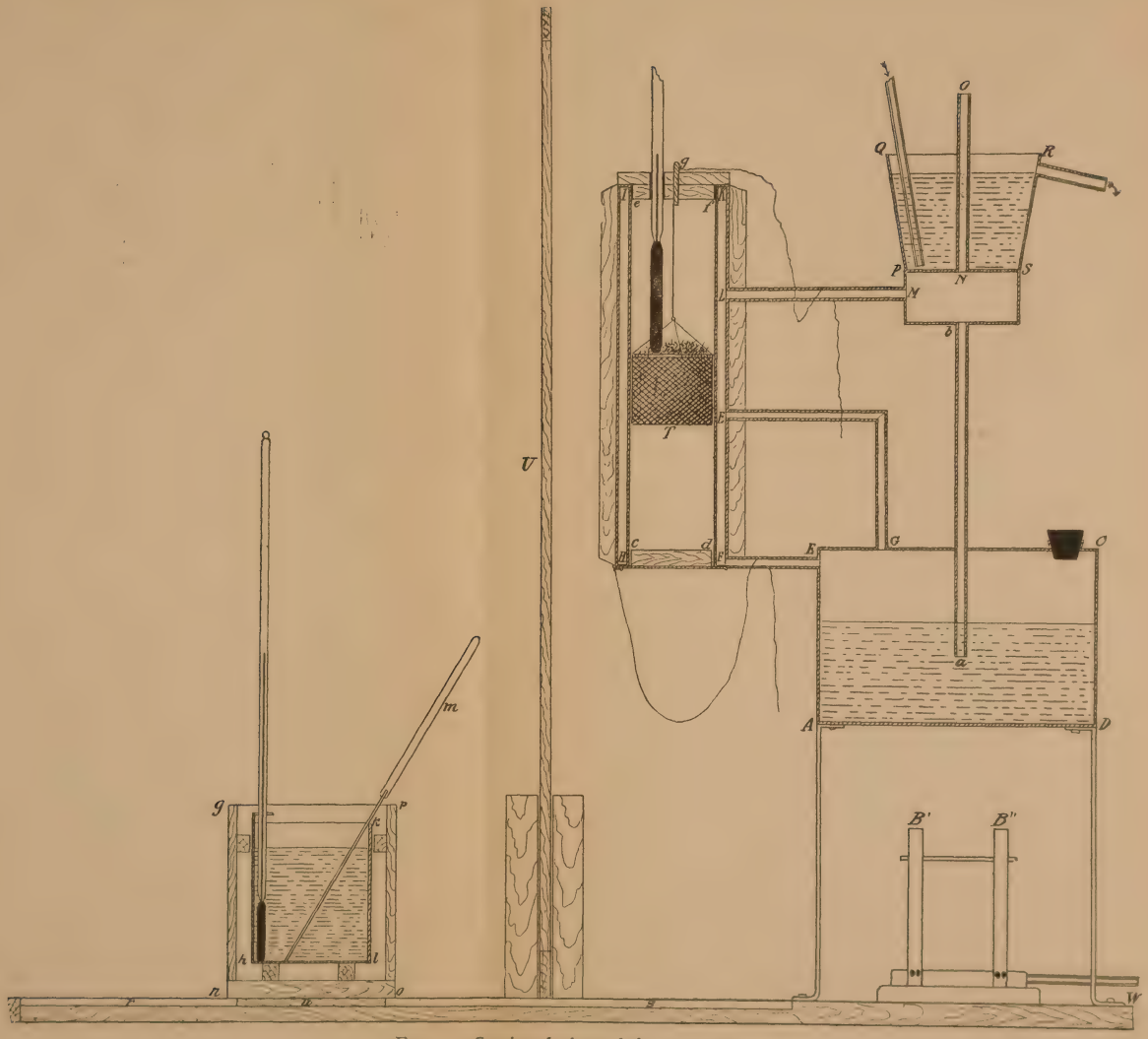


FIG. 1.—Sectional view of the apparatus.

The dimensions of the former again are taken in such a way that 0°·01 can be estimated, and that the column of mercury, when indicating the temperature of the brine in the beginning of the test, does not project much over the surface of the same. Calorimeter *h i k l* is put in the wooden box *n o p q*. The board *V W*, which supports the whole apparatus, has the groove *r s* in its longitudinal extension. Box *n o p q* having at its bottom the projecting board *u* fitting groove *r s*, can easily be made to slide forward and backward under the cylinder *c d e f*, after partition *U* has been moved backwards. After the apparatus is properly adjusted, the burner B_I B_{II} are lit. When the thermometer in *c d e f* indicates a constant temperature, the temperatures indicated by each thermometer and the time are noted down, partition *U* is moved backwards, lid *c d* swung open, box *n o p q* slid under cylinder *c d e f*, basket *T* lowered into calorimeter *h i k l*, box *n o p q* slid back, partition *U* removed into its previous place, and the ascension of the thermometer in the calorimeter *h i k l* is watched. As soon as it begins to go down, the time is noted down again, thus giving us the number of seconds during which the thermometer ascended. From the moment it begins to descend, during some minutes the temperatures indicated by the thermometer every sixty seconds are noted down. From the figures thus obtained, the specific heat of the brine can be calculated.

Further below, I give the four authentic proofs for the determination of the specific heat of brine of 1·1875 specific gravity. In the following I shall add to each item the figures obtained from the third of these four tests.

If *M* means the weight of brass tacks and basket together (446·0 grammes);

σ means the specific heat of brass (0·0939);

m means the weight of the brine filled into the calorimeter *h i k l* (510·0 grammes);

T means the temperature prevailing in cylinder *c d e f* (95°·771 Cels.);

τ means the temperature of the brine indicated by the thermometer at the beginning of the test (21°·20);

τ_1 means the temperature of the brine indicated by the thermometer at the end of the test (28°·05);
$\varkappa$ means the specific heat of the brine that is to be determined;

we arrive at the following equation:

$$\varkappa m(\tau_1 - \tau) = \sigma M(T - \tau_1) \qquad (1)$$

In this equation we did not take into consideration the heat which is absorbed by the brass of the calorimeter *h i k l*, and the thermometer in it for being heated up from τ to τ_1 degrees.

If μ means the weight of the brass calorimeter (75·2 grs.);
μ_2 means the weight of the thermometer in it;
σ_2 means the specific heat of the thermometer, and these values are introduced into equation (1);

we obtain equation

$$\varkappa m(\tau_1 - \tau) + \sigma \mu (\tau_1 - \tau) + \mu_2 \sigma_2 (\tau_1 - \tau) = \sigma M (T - \tau_1) \qquad (2)$$

$\mu_2 \sigma_2$ is determined in the following manner: The thermometer is put in warm water, then put in a weighed quantity of cooler water and it is observed what temperature the water has obtained by the bringing in of the thermometer.

If θ means the temperature of the thermometer when put in the water;
ϑ means the temperature of the water before the thermometer was put in;
ϑ_1 means the temperature of the water after the thermometer had been put in;
m_1 means the weight of the water;

we obtain

$$\sigma_2 \mu_2 (\theta - \vartheta_1) = m_1 (\vartheta_1 - \vartheta)$$

or

$$\sigma_2 \mu_2 = \frac{m_1 (\vartheta_1 - \vartheta)}{\theta - \vartheta_1}$$

The value for $\sigma_2 \mu_2$ is the same in all tests. The observations having been:

θ, ...	= 29°·84	29°·18	29°·77	29°·78
ϑ, ...	= 20° 85	20°·74	20°·80	20°·82
ϑ_1, ...	= 23°·06	22°·67	22°·86	22°·96
m_1, ...	= 5·7 grs.	5·7 grs.	5·7 grs.	5·7 grs.
we find $\mu_2 \sigma_2$ =	1·86 grs.	1·67 grs.	1·69 grs.	1·78 grs.

average of $\mu_2 \sigma_2$ . . . . . = 1·75 grs. of water.

But we have to make one correction more. In these equations we admitted the difference $\tau_1 - \tau$ to be in reality

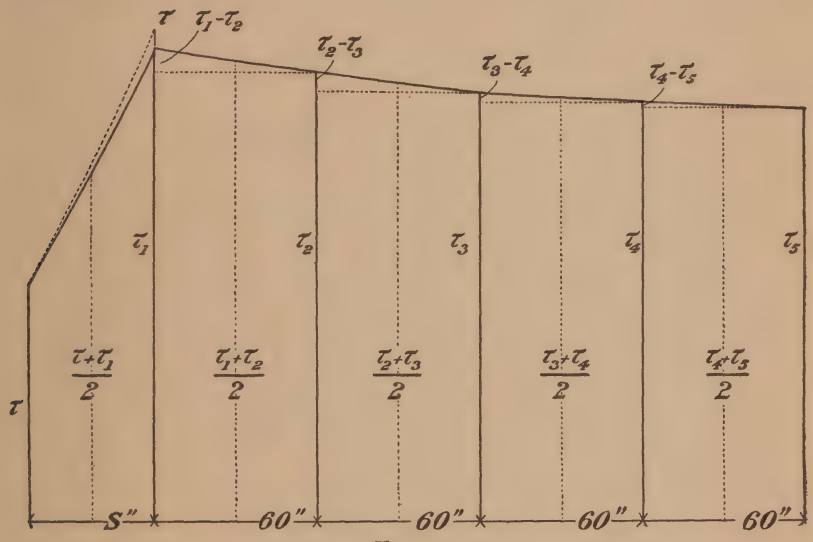


FIG. 2.

all the heat given by the brass tacks and basket to the brine in the calorimeter, to the calorimeter itself and to the thermometer in it. But this supposition is not true, as during the tests the brine, calorimeter and thermometer lost heat by radiation and by the cooling influence of the air. Without this loss of heat the thermometer would not only have gone up to τ_1 degrees (see *Fig. 2*), but a little more, to $\tau_1 + \delta$ degrees. This δ is determined in the following manner:

It took s seconds (45″) to raise the temperature of the brine from τ to τ_1 degrees. Then after having stopped a moment, the thermometer began to go down. It went

down in the first sixty seconds from τ_1 to τ_2, in the next sixty seconds from τ_2 to τ_3, from τ_3 to τ_4, from τ_4 to τ_5, or the decreases were $\tau_1 - \tau_2$, $\tau_2 - \tau_3$, $\tau_3 - \tau_4$, $\tau_4 - \tau_5$, the values

$$\frac{\tau_1 + \tau_2}{2} \qquad \frac{\tau_2 + \tau_3}{2} \qquad \frac{\tau_3 + \tau_4}{2} \qquad \frac{\tau_4 + \tau_5}{2}$$

representing the average temperatures prevailing during each sixty seconds. It is :

$$\tau_1 - \tau_2 = \frac{\tau_1 + \tau_2}{2} \cdot 60 \cdot k_1$$

$$\tau_2 - \tau_3 = \frac{\tau_2 + \tau_3}{2} \cdot 60 \cdot k_2$$

$$\tau_3 - \tau_4 = \frac{\tau_3 + \tau_4}{2} \cdot 60 \cdot k_3$$

$$\tau_4 - \tau_5 = \frac{\tau_4 + \tau_5}{2} \cdot 60 \cdot k_4$$

If we dissolve these equations for k, we obtain

$$k_1 = \frac{2(\tau_1 - \tau_2)}{(\tau_1 + \tau_2)\,60}$$

$$k_2 = \frac{2(\tau_2 - \tau_3)}{(\tau_2 + \tau_3)\,60}$$

$$k_3 = \frac{2(\tau_3 - \tau_4)}{(\tau_3 + \tau_4)\,60}$$

$$k_4 = \frac{2(\tau_4 - \tau_5)}{(\tau_4 + \tau_5)\,60}$$

and by taking the average of $k_1\ k_2\ k_3\ k_4$, the value of k, *i. e.*, of a coëfficient, which multiplied by the number of seconds which the test lasted, and by the average temperature prevailing during each second, gives the fraction of a degree δ by which more the thermometer in the calorimeter would have gone up, if there had been no loss of heat by radiation and by the cooling influence of the air.

The average temperature during the s seconds (45″) while the thermometer ascended having been

$$\frac{\tau + \tau_1}{2} \text{ degrees,}$$

we have

$$\delta = \frac{\tau + \tau_1}{2} \cdot s \cdot k$$

or the real number of degrees by which the brine in the calorimeter was heated up was $\tau_1 + \delta - \tau$ degrees.

We observed

$\tau = 21°{\cdot}20$

$\frac{\tau + \tau_1}{2} = 24°{\cdot}625 \qquad s = 45''$

$\tau_1 = 28°{\cdot}05$

$\tau_1 - \tau_2 = 0°{\cdot}10$

$\tau_2 = 27°{\cdot}95$

$\tau_2 - \tau_3 = 0°{\cdot}05$

$\tau_3 = 27°{\cdot}90$

$\tau_3 - \tau_4 = 0°{\cdot}04$

$\tau_4 = 27°{\cdot}86$

$\tau_4 - \tau_5 = 0°{\cdot}02$

$\tau_5 = 27°{\cdot}84$

Introducing these figures into the equations above-mentioned, we obtain

$$\left.\begin{aligned} k_1 &= 0{\cdot}000060 \\ k_2 &= 0{\cdot}000030 \\ k_3 &= 0{\cdot}000024 \\ k_4 &= 0{\cdot}000012 \end{aligned}\right\} k = 0{\cdot}000031$$

Hence follows $\delta = 24{\cdot}625 \,.\, 0{\cdot}000031 \,.\, 45 = 0°{\cdot}034$ and $\tau_1 + \delta = 28°{\cdot}084$ and $\tau_1 + \delta - \tau = 6°{\cdot}884$.

Introducing this correction into equation (2) we obtain equation

$$\varkappa m (\tau_1 + \delta - \tau) + \sigma \mu (\tau_1 + \delta - \tau) + \sigma_2 \mu_2 (\tau_1 + \delta - \tau) = \sigma M [T - (\tau_1 + \delta)] \qquad (3)$$

and by dissolving it for $\varkappa$ we have

$$\varkappa = \frac{\sigma [M (T - (\tau_1 + \delta)) - \mu (\tau_1 + \delta - \tau)] - \mu_2 \sigma_2 (\tau_1 + \delta - \tau)}{m (\tau_1 + \delta - \tau)}$$

$$= 0{\cdot}79053$$

AUTHENTICAL PROOFS FOR THE SPECIFIC HEAT OF BRINE OF 1·1875 SP. GR.

	I.	II.	III.	IV.
M,	446·0 grs.	446·0	446·0	446·0
μ,	75·2 "	75·2	75·2	75·2
σ,	0·0939	0·0939	0·0939	0·0939
$\mu_2\ \sigma_2$,	1·75 grs.	1·75	1·75	1·75
m,	510·0 "	510·0	510·0	510·0
T,	95°·74	95·85	95·77	96·04
τ,	21°·36	21·84	21·20	21·50
τ_1,	28°·22	28·62	28·05	28·36
τ_2,	28°·15	28·57	27·95	28·27
τ_3,	28°·12	28·54	27·90	28·20
τ_4,	28°·11	28·50	27·86	28·16
τ_5,	28°·10	28·46	27·84	28·11
$\tau_1 - \tau_2$,	0°·07	0·05	0·10	0·09
$\tau_2 - \tau_3$,	0°·03	0·04	0·05	0·07
$\tau_3 - \tau_4$,	0°·01	0·04	0·04	0·05
$\tau_4 - \tau_5$,	0°·01	0·03	0·02	0·04
k,	0·000018	0·000017	0·000031	0·000037
s,	60″	100	45	50
δ,	0°·0268	0·043	0·034	0·045
$\tau_1 + \delta$,	28°·2468	28·663	28·084	28·405
$\tau_1 + \delta - \tau$,	6·8868	6·823	6·884	6·905
$T - (\tau_1 + \delta)$,	67·4932	67·187	67·686	67·635
χ,	0·78778	0·79180	0·79053	0·78732

Average of χ, ... 0·78936

This average value differs from the highest value obtained, ... 0·31 per cent.
This average value differs from the smallest value obtained, ... 0·26 per cent.

If we have to determine the specific heat of a solid body which is soluble in water (in this case salt), we put a weighed quantity of it in the basket T which, of course, is to be made of brass sheathing in this case, and in the calorimeter $h\ i\ k\ l$ a liquid which does not dissolve the body (in this case mineral oil), and the specific heat of which is known.

If M_1 means the weight of the salt, filled into the basket;
m_1 means the weight of the mineral oil;
σ_1 means its specific heat;
μ_1 means the weight of the empty brass basket;
x_1 means the specific heat of the salt that is to be determined, the other letters having the same meaning as formerly;

we arrive at the following equation:

$$x_1 = \frac{\sigma_1 m_1 (\tau_1 + \delta - \tau) + \mu_2 \sigma_2 (\tau_1 + \delta - \tau) + \sigma [\mu (\tau_1 + \delta - \tau) - \mu_1 (T - (\tau_1 + \delta))]}{M_1 (T - (\tau_1 + \delta))}$$

I obtained as average figure of the specific heat of salt 0·228.

ADDITIONAL NOTES ON THE COMPOSITION OF THE LIQUID AMMONIA OF THE TRADE, ETC.

By Dr. Hans von Strombeck.

A few weeks ago, just after my paper "On the Composition of the Liquid Ammonia of the Trade" had been presented to the Chemical Section of the Institute, Mr. Louis Block, Chief Engineer of the De La Vergne Refrigerating Machine Company, showed me a piece of a black, dough-like paste which had been scraped out of the compressor of a refrigerating machine. He said that this paste had interfered with the proper working of the valves of the compressor, and thus with the proper working of the whole plant, and requested me to ascertain how this paste could have been formed, and how its formation could be prevented. The weight of the paste scraped out was only 35·24 grains or about one-twelfth ounce. As a superficial examination of the paste showed the presence of a considerable percentage of iron, I thought first that the mineral oil used in the compressor might contain some mineral acid or some fatty oil which by setting free fatty acid had acted on the valves of the compressor. But an examination of the oil used proved it to be pure mineral oil of the same chemical and physical

properties as usual. I then made a thorough analysis of the black paste; that is to say, as thorough as the small available quantity of substance allowed.

The 35·24 grains of the black paste consist of:

Grains.		*Per Cent.*	
3·0860	=	8·7565	of moisture.
4·2278	=	11·9965	of mineral oil.
0·0092	=	0 0260	of ammonium-sulphide.
0·1137	=	0·3227	of sulphate of ammonia.
0·0779	=	0·2210	of ammonium-chloride.
6·2489	=	17·7324	of organic matter soluble in water.
6·5302	=	18·5301	of peroxide of iron.
0·7601	=	2·1569	of iron-sulphide.
14·1862	=	40·2579	of (by difference) insoluble organic matter.
35·2400		100·0000	

The kind of bodies found made me suppose that the formation of the black paste is due to the action of impurities contained in the liquid ammonia on the valves and the oil in the compressor, and the analyses of five liquid ammonias, which had been made of different raw materials and by different processes, prove that my supposition was correct:

	G. *Per Cent.*	*H.* *Per Cent.*	*I.* *Per Cent.*	*K.* *Per Cent.*	*L.* *Per Cent.*
Ammonia (by difference), . .	97·9260	98·8040	99·9304	99·9449	99·3115
Colorless fluid, ...	1·4322	0 9734	0·0307	0·0084	0·0270
Moisture, ...	0·5882	0·1962	0·0281	0·0260	0·0266
Mineral oil, ...	0·0158	0·0120	0·0032	0·0038	0·0108
Hartshorn salt of ammonia, .	0·0304	0·0094	0·0064	0·0159	0·0235
Ammonium-sulphide, ...	0·0008	0·0033	0·0002	0·0005	0·0002
Sulphate of ammonia, ...	0·0042	0·0014	0·0004	0·0005	traces
Ammonium-chloride, ...	0·0002	0·0001	traces	traces	0·0004
Mineral matter suspended, . .	0·0022	0·0002	0·0006	traces	traces
	100·0000	100·0000	100·0000	100·0000	100·0000

Sample *L* contains also some resinous matter. Now it seems impossible that such small quantities of ammonium-sulphide and chloride, sulphate and carbonate of ammonia as found in these ammonias can destroy enough iron and oil to explain the presence of the black paste. For, if we take a plant in which 2,000 pounds of such ammonia as analyzed under *G* circulate, the contaminations contained in the 2,000 pounds can only eat off 0·44 pounds of iron. By distributing this loss of iron over the whole interior surface of the pipes, etc., of the plant; that is to say, over a surface

of 1,000 square feet and more, it will be seen that the loss undergone by the valves is only infinitesimally small. Thus the damage done by these contaminations would be equal to nothing if the reaction between the acids contained in them and the metal took place only *once* and stopped as soon as the formation of the neutral salt had taken place. But this is not so. By the electricity generated by the working of a refrigerating plant the sulphate and carbonate of ammonia, the ammonium-sulphide and chloride are decomposed, their acids combining with the iron of the pipes, etc., and decomposing the oil. The iron salts thus formed afterwards dissolve in the water, always sufficiently present, and in the ammonia and are transformed again into sulphate, etc., of ammonia, the iron being separated out and being more or less oxidized by the oxygen of the air, which is always present in small quantities. The newly formed sulphate, etc., of ammonia is decomposed again by the electric current, and so on, a continuous circuit being formed. In this way by a very small quantity of impurities of this kind, considerable quantities of iron and oil, can be destroyed and the proper working of the plant interfered with, the latter so much more, as in its most sensitive point in the compressor the action of the acids is most energetic because of the high temperature (150°) prevailing there.

To avoid the formation of such a black paste and its unpleasant consequences it is therefore necessary to use in a refrigerating machine only such liquid ammonias out of which all ammoniacal salts have been removed. While this removal can be done in different ways, my new process of purifying ammonia (described in the July number of this journal) simultaneously with the other impurities stated, also takes these ammoniacal salts out, the reactions being the same as described in equation (III) viz:

$$\text{(IV)} \quad (NH_4)_2\,So_4 + Na_2 = Na_2\,So_4 + 2NH_3 + H_2$$

$$\text{(V)} \quad (NH_4)_2\,S + Na_2 = Na_2\,S + 2NH_3 + H_2$$

$$\text{(VI)} \quad 2NH_4\,Cl + Na_2 = 2NaCl + 2NH_3 + H_2$$

Laboratory of the
De La Vergne Refrigerating Machine Company,
New York, July 18, 1892.

PROCEEDINGS.

[*Stated meeting, held Tuesday, September 20, 1892.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, September 20, 1892.

Dr. Wm. H. Wahl, President, in the chair.

Dr. Bruno Terne read an interesting and valuable paper, giving an account of the meeting of the Association of Agricultural Chemists, held recently in Washington. The paper included an historical account of the association and a critical consideration of the merits of the analytical methods approved by the association for the quantitative analysis of fertilizers. The paper was discussed by the author and Mr. Williams, of Wilmington.

The Section then adjourned. WM. C. DAY, *Secretary.*

PROCEEDINGS.

[*Stated meeting, held Tuesday, October 18, 1892.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, October 18, 1892.

Dr. Wm. H. Wahl, President, in the chair.

The resignation of Mr. G. L. Norris was presented, and on motion was accepted by vote of the Section.

The Treasurer called attention to the name of a member whose dues have not been paid for two years; according to the by-laws the name was dropped from the list of members.

The President proposed for membership Mr. J. Benjamin Glavin, 1312 Passyunk Avenue, Philadelphia; the name was referred to the Committee on Admissions and Mr. Glavin was elected a member of the Section.

The Actuary of the Institute presented two bills from the Institute for subscriptions to various journals. The contraction of these bills having already been authorized by the Section, the bills were ordered paid and they were accordingly submitted to the Treasurer of the Section for payment. The Actuary also requested authority to pay for subscriptions to journals from February of the present year to date. These bills amounted to a total of 59·40 marks. On vote the necessary authority was granted.

In view of the fact that Dr. Harvey Wiley, of the Agricultural Department, at Washington, is to lecture at the Franklin Institute on the evening of the 5th of December, of the present year, Dr. Terne suggested that it would be fitting for the Chemical Section to tender him a reception after the

close of his lecture. The suggestion was favorably considered and on motion the President was requested to name a committee to consider the question of the arrangement and form of the reception; the committee was requested to report at the next meeting of the Section. The President named Dr. Terne, Dr. Jayne and Mr. Pemberton as members of this committee.

Mr. Geo. W. Whyte, of the Camden Iron Works, then read a paper entitled "The Washing of a Southern Coal; Comparison of Laboratory Results with those of Actual Washing Test." The paper gave some valuable results of quite a large amount of experimental work and was listened to with much interest by the members present.

The discussion which followed was conducted by the author, the President and Mr. Pemberton. An abstract of the paper will be published in the *Journal* of the Institute.

Mr. Palmer followed with a note on "A Lilac Color from Extract of Chestnut." Mr. Palmer's remarks were as follows:

"In experimenting with a commercial extract of chestnut wood, with the idea of making galloflavine therefrom, an unlooked-for result was obtained. The extract was somewhat fermented; that is, a part of the tannin had been changed into gallic acid; and the design was to convert this gallic acid into galloflavine by the usual method.

"A solution of the 51° extract was made strongly alkaline with potash, and subjected to the action of a stream of air for about ten hours. The temperature, meantime, was kept below 50° F. At the end of the period of oxidation, the potash was neutralized with acetic acid. The solution so obtained was tested for galloflavine by working therein cotton and wool yarns with the addition of potash alum. While no yellow color was obtained, a clear, bright lilac was developed on both the animal and the vegetable fibre.

"The body giving this color has not as yet been separated from the oxidized extract."

The Section then adjourned. WM. C. DAY, *Secretary.*

PROCEEDINGS.

[*Stated meeting, held Tuesday, November 15, 1892.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, November 15, 1892.

Dr. Wm. H. Wahl, President, in the chair.

Dr. Jayne presented a report on behalf of the special committee appointed to arrange for a reception to be given to Professor Wiley, on the evening of December 6, 1892.

On motion, the report was accepted and the committee was given power to arrange the necessary details.

Nominations for officers for the ensuing year were then made as follows:

For *President*,	Prof. Edgar F. Smith, Dr. Wm. H. Greene.
For *Vice-Presidents* (two to be elected),	Mr. Henry Bower, Dr. D. K. Tuttle.
For *Secretary*,	Dr. Wm. C. Day.
For *Treasurer*,	Dr. H. W. Jayne.
For *Conservator*,	Dr. Wm. H. Wahl.

Mr. H. Pemberton, Jr., on behalf of himself and Mr. George P. Tucker, read a paper on "Deposits of Native Soda near Laramie, Wyoming." Referred for publication.

Dr. Wm. H. Wahl read a paper, entitled "Observations on Ferro-Tungsten." Both papers called forth considerable discussion.

The Section then adjourned.

H. PEMBERTON, JR., *Secretary pro tem.*

REPORT OF THE PROCEEDINGS OF THE NINTH ANNUAL MEETING OF OFFICIAL AGRICULTURAL CHEMISTS, HELD AT WASHINGTON, AUGUST 25–27, 1892, WITH SPECIAL REFERENCE TO THE METHODS ADOPTED FOR THE CONTROL OF THE FERTILIZER TRADE.

By Dr. Bruno Terne.

[*Read at the stated meeting of the Chemical Section, held October 18, 1892.*]

Mr. President and Members of the Chemical Section:

Looking over the wide field of scientific societies, and more especially over the chemical organizations of our country, I know of none which has, in the short time since its creation, done so much practical good work for the benefit of the interested circles as the Association of Official Agricultural Chemists.

Still, when we come to criticise its work of the last few years, we cannot deny the fact that the results gained are not in proportion to the work done. Although encouraging, the results are far from being final.

A short historical sketch of the association will doubtless interest you, and serve as an introduction to the remarks which I propose to make in regard to the results of the last meeting of the said association.

With the revival of business in the Southern States the consumption of fertilizing materials for the cotton plantations soon assumed enormous proportions.

The valuation of this material, based on chemical analysis, was a source of great trouble both to seller and buyer, caused by the unconcerted action of the chemical laboratories.

There were in use all possible methods for the determination of the different ingredients.

This chaotic state of affairs has been changed by the concerted action of the analytical chemists interested in such work, and the gain of this very important point is the fruit of the earnest work of this association.

The beginning of the organization dates from the following circular-letters:

DEPARTMENT OF AGRICULTURE,
ATLANTA, Ga., May 20, 1880.

DEAR SIR:—The experience of the last fertilizer season has suggested to my mind the importance of securing such uniformity of method in determining, by chemical analysis, the percentage of valuable ingredients in commercial fertilizers, as will give more uniform, and hence more satisfactory results. This is especially desirable in determining reverted phosphoric acid.

With a view to accomplishing so desirable an object, as well as others which may be deemed proper, I have the honor to suggest the calling of a convention of the several Commissioners of Agriculture, representatives from State Boards of Agriculture, State chemists and professors of chemistry in State universities and State agricultural colleges, in those States using large amounts of commercial fertilizers, to meet at some convenient point early in the month of July next.

I would be glad to have your views on the subject; and if favorable to the suggestion please nominate some gentleman who, by general assent, may be informally authorized to fix the time and place of such convention, and issue the necessary notices. You are also requested to give me the names and post-offices of gentlemen in your State, holding either of the above positions indicated, which do not appear in the list below, that copies of this circular may be sent to them. An early reply is desirable.

Very respectfully,
J. T. HENDERSON,
Commissioner of Agriculture.

DEPARTMENT OF AGRICULTURE,
ATLANTA, Ga., July 1, 1880.

DEAR SIR:—I am gratified to announce that the recent circular-letter which I had the honor to issue, suggesting the calling of a convention for the purpose of adopting a

uniform system for the analysis of commercial fertilizers, has met with favorable responses from a large majority of the gentlemen to whom it was sent. A like majority has imposed upon me the duty of fixing the time and place of said convention, and issuing the necessary notices for the same. After correspondence with others, and due consideration of the interests involved, I have decided upon Wednesday, the 28th of July, as the time, and Washington, D. C., as the place for the assembling of the proposed convention. You are, accordingly, respectfully and earnestly invited to be present and participate in the convention.

Every reasonable facility for the deliberations of the convention will be afforded by Hon. Wm. G. LeDuc, Commissioner of Agriculture, who is in hearty sympathy with the object sought to be accomplished. I have appended hereto a list of the names of gentlemen to whom this circular will be sent.

Trusting that you will find it convenient to attend and give the convention the benefit of your experience, and requesting that you will at once inform me by letter whether you will attend, I am, Respectfully,

J. T. HENDERSON,
Commissioner of Agriculture.

The first convention met on the day set for and adopted methods for the determination of phosphoric acid, nitrogen and potash to be used during the ensuing year.

This meeting was followed by meetings in Cincinnati, Atlanta, and in 1884 in Philadelphia.

The convention in our city was the most important one for the organization, because the association adopted (September 9th) the new Constitution, and made itself entirely independent of its former connections as a subdivision of the Section of Chemistry of the American Society for the Advancement of Science.

The first two paragraphs of the Constitution are of general interest.

(1) "This association shall be known as the Association of Official Agricultural Chemists in the United States. Its

object shall be to secure, as far as possible, uniformity in legislation with regard to the regulation of the sale of commercial fertilizers in the different States and uniformity and accuracy in the methods and results of fertilizer analysis.

(2) "Analytical chemists connected with Departments of Agriculture, State Agricultural Experiment Stations and State Boards, exercising an official fertilizer control, shall alone be eligible to membership; and one such representative from each of these institutions, when properly accredited, shall be entitled to a vote in the association. All analytical chemists and others interested in the objects of the association may attend its meetings and take part in its discussions, but shall have no vote in the association."

The exclusion of all chemists not to be classified as officials, from full membership, varies from the custom of England and Germany.

It is not my intention to question either the motive or the wisdom of this regulation, or of another rule denying the right to enter a motion which has been in force since 1891, as it certainly gives the excluded more liberty to criticise than if he were made responsible by his vote for the action of the society.

Since the Philadelphia meeting the society has made its headquarters in Washington, where, under the patronage of the Department of Agriculture, the annual meetings are held. The untiring efforts of the Secretary of the society, Mr. Harvey W. Wiley, Chief Chemist of the Department of Agriculture, have secured to the association the support of the Administration, and enabled the same to publish the results of their annual work, as a *Bulletin* of the Department, division of chemistry.

These annual reports are edited by the able pen of Professor Wiley and are an excellent guide for all connected with the interests of the society.

The scope of work of the association has extended to a wider field than was originally planned, including at present all station work in the interest of the farming community.

Besides the fertilizers analysis, we have had during the last year reports on analysis of fermented liquors, dairy

DETERMINATION OF POTASH BY THE LINDO-GLADDING METHOD WITH AND WITHOUT SODIUM CHLORIDE.

Names of Analysts and Location. Official Laboratories.	Sample No. 1.		Sample No. 2.		Sample No. 3.		Sample No. 4.	
	With NaCl.	Without NaCl.	With NaCl.	Without NaCl.	With NaCl.	Without NaCl.	With NaCl.	Without NaCl.
Norman Robinson, State Chemist, Tallahassee, Fla.,	48·83	48·70	1·58	1·59	1·47	1·46	1·40	1·41
F. S. Shiver, Assistant of State Chemist, Fort Hill, S. C. (*a*),	49·05	49·13	1·45	1·44	1·40	1·39	1·40	1·44
F. S. Shiver, Assistant of State Chemist, Fort Hill, S. C. (*b*),	49·00	—	1·45	—	1·40	—	1·32	—
P. L. Hutchinson, Assistant of State Chemist, Atlanta, Ga.,	49·05	49·15	1·50	1·48	1·51	1·40	1·48	1·40
J. F. Wilkinson, Assistant of State Chemist, Atlanta, Ga.,	49·13	49·12	1·50	1·52	1·47	1·42	1·36	1·34
F. B. Carpenter, Experiment Station, Raleigh, N. C.,	48·94	—	1·61	—	1·48	—	1·56	—
Thos. L. Blalock, Experiment Station, Raleigh, N. C. (*a*),	48·76	48·76	1·63	1·63	1·48	1·46	1·48	1·47
Thos. L. Blalock, Experiment Station, Raleigh, N. C. (*b*),	48·96	49·10	—	—	—	—	—	—
Thos. L. Blalock, Experiment Station, N. C. (*c*),	48·90	48·91	1·59	1·58	1·51	1·48	1·46	1·45
Louis A. Voorhees, Experiment Station, New Brunswick, N. J.,	49·23	49·19	1·49	1·46	1·35	1·36	1·36	1·37
Louis A. Voorhees, Experiment Station, New Brunswick, N. J.,	49·27	49·29	1·51	1·52	1·38	1·42	1·36	1·37
Chas. S. Cathcart, Agricultural College, New Brunswick, N. J.,	49·31	49·34	1·52	1·46	1·43	1·45	1·35	1·33
E. H. Farrington, Experiment Station, Champaign, Ill.,	49·29	49·00	1·77	1·64	1·77	1·66	1·62	1·51
Thos. L. Watson, Experiment Station, Blacksburg, Va., Assistant Chemist,	49·19	48·95	1·55	1·58	1·41	1·42	1·41	1·36
R. C. Kedzie, Agricultural College P. O., Mich.,	48·75	48·69	1·55	1·53	1·54	1·51	1·67	1·65
Rudolph de Roode, Experiment Station, Morgantown, W. Va.,	48·96	48·96	1·52	1·55	1·42	1·42	1·37	1·39
Rudolph de Roode, Experiment Station, Morgantown, W. Va.,	49·04	49·04	1·57	1·53	1·48	1·40	1·39	1·37
C. B. Collingwood, Experiment Station, Tucson, Ariz.	48·62	48·38	1·51	1·47	—	—	—	—
Henry E. Curtis, Experiment Station, Lexington, Ky.,	49·00	48·91	1·45	1·46	1·43	1·40	1·39	1·37
W. S. Sweetser, Experiment Station, State College P. O., Pa.,	49·26	49·28	1·69	1·57	1·58	1·53	1·45	1·43
W. S. Sweetser, Experiment Station, State College P. O., Pa.,	49·30	49·29	1·62	1·57	1·51	1·51	1·45	1·40
H. B. McDonnell, State Chemist, College Park P. O., Md.,	48·47	48·69	1·65	1·61	1·58	1·55	1·48	1·45
W. D. Bigelow, U. S. Department of Agriculture, Washington, D. C.,	48·56	48·31	1·49	1·58	1·57	1·37	1·47	1·42
Average,	48·994	48·961	1·554	1·538	1·484	1·456	1·439	1·417
Difference,	—	·033	—	·016	—	·028	—	·022
Unofficial Laboratories.								
Shepard Laboratory, Charleston, S. C.,	49·88	49·80	1·87	1·91	1·75	1·74	1·66	1·55
Elwyn Waller School of Mines, Columbia College, New York City,	49·67	49·17	1·60	1·46	1·61	1·53	1·59	1·59
Elwyn Waller School of Mines, Columbia College, New York City,	49·89	48·71	1·62	1·52	1·56	1·52	—	1·53
Elwyn Waller School of Mines, Columbia College, New York City,	—	48·21	—	—	—	—	—	—
Elwyn Waller School of Mines, Columbia College, New York City,	—	48·69	—	—	—	—	—	—
H. T. Vulte, Assistant of Elwyn Waller School of Mines, Columbia College, New York City,	48·88	48·54	1·66	1·58	1·58	1·58	1·58	1·52
B. C. Hinman, Assistant of Elwyn Waller School of Mines, Columbia College, New York City,	—	48·99	—	1·51	1·67	1·40	1·41	1·40
F. S. Hyde, Student of School of Mines, Columbia College, New York City,	49·43	49·47	1·35	1·42	—	—	—	—
Average,	49·550	48·948	1·620	1·566	1·634	1·544	1·560	1·518
Difference,	—	·602	—	·054	—	·090	—	·042
Total average,	49·093	48·957	1·566	1·545	1·543	1·474	1·458	1·438
Difference,	—	·136	—	·021	—	·069	—	·020
Highest,				49·89		1·87	1·77	1·67
Lowest,				48·62		1·35	1·35	1·32
Difference,				1·27		0·52	0·42	0·35

products, foods rich and poor in carbo hydrates, and on sugar.

During the last four years I have regularly attended the meetings of the association as a non-member, and taken much interest in the analysis of commercial fertilizers.

It was with great pleasure that I attended the meetings from August 25th to 27th of this year.

I will now report the proceedings, referring for the methods in use to the official *Bulletin* No. 31, 1891:

REPORT ON POTASH.

For the Association of Official Agricultural Chemists of the United States.

By Dr. George F. Payne, Atlanta, Ga.

The work required by the association, of the reporter on potash for 1892, was an investigation as to whether the use of sodium chloride was essential in the Lindo-Gladding method of determining potash.

Four samples were prepared and were numbered one, two, three and four.

No. 1 was a high grade sulphate of potash.

No. 2 was an acid phosphate with sulphate of potash in the form of kainit.

No. 3 was an acid phosphate with sulphate of potash in the form of kainit, and containing five per cent. of double sulphate of alumina and ammonia.

No. 4 was identical with No. 3 with the substitution of five per cent. of soluble sodium silicate in place of the double salt of alumina and ammonia.

The ingredients of each sample were first finely powdered and thoroughly mixed, then sifted through a very fine sieve, then again intimately mixed and portions taken from forty different parts of the pile were well re-mixed and used for filling the bottles. Only the best XX superfine long taper corks were used, and were selected long enough to project well from the mouth of the vial to secure easy opening and air-tight re-corking. The corks were all well sealed with paraffine. With each package a circular was sent requesting that the determinations be made as soon as convenient after receiving samples to eliminate as far as possible any differences likely to occur from changes in the amount of moisture after bottling.

Each chemist was also requested to carry out the method as ordinarily managed in his laboratory, working each sample with and without sodium chloride, side by side, and as nearly as possible under exactly the same conditions.

Twenty-two chemists took part in the work and their results were as follows: [See table inserted here.]

The method of Lindo-Gladding for potash determination is a very satisfactory one. The addition of NaCl is absolutely unnecessary, and will now be stricken out of the official methods.

The great differences in potash which often arise between guarantee of brand and anaylsis are not to be attributed to the method, but in most of the cases to the unequal mixing of the products.

I have shown in a paper read before the association at the August meeting of 1891, *Bulletin* No. 31, pp. 150, 152, the extreme difficulty of making mechanical mixtures sufficiently uniform to cover chemical guarantees, when for example eighty pounds or even 100 pounds of high grade muriate of potash at a guarantee of fifty per cent. potash, the bearer of the potash in a ton of mixture.

The same experience has been made by others, and the reports on potash give a vivid picture of this evil, which seems to grow as we go further South.

The report on determination of nitrogen was made by Mr. Van Slyke, of Seneca, N. Y. The report appears in the accompanying table. [See p. 7.]

The work on determination of nitrogen has, from the beginning, given the most satisfactory results.

The introduction of the Kjeldahl methods several years ago has given occasion for the careful testing of this method in its original and modified form.

In 1887, Prof. M. A. Scovell, of Louisville, Ky., introduced a modification to make the Kjeldahl method likewise applicable to nitrates by the use of salicylic acid (*Bulletin* No. 16, 1887, pp. 51–54) which at the meeting of 1888 was adopted as official.

The methods adopted as official methods:

(1) The absolute or cupric oxide method.
(2) The Kjeldahl method, not applicable in presence of nitrate.
(3) The Kjeldahl method, modified by Scovell, applicable to all fertilizers containing nitrates.

Terme.

I. Bone Meal.				II. Cotton-seed Meal.				State.	Analyst.	III. Sodium Nitrate.	
Kjeldahl Method with Permanganate.	Kjeldahl Method without Permanganate.	Gunning Method with Permanganate.	Gunning Method without Permanganate.	Kjeldahl Method with Permanganate.	Kjeldahl Method without Permanganate.	Gunning Method with Permanganate.	Gunning Method without Permanganate.			Ulsch Method.	Kjeldahl-Scoville Method.
first.	*second.*	*third.*	*fourth.*	*first.*	*second.*	*third.*	*fourth.*				
4·41	4·42	4·40	4·39	7·15	7·12	7·14	7·15	Arkansas.	Teller.		
4·46	4·48	4·50	4·42	7·17	7·23	7·31	7·09	Illinois.	Farrington.		
4·50	4·43	4·45	4·46	7·27	7·16	7·18	7·22	Kentucky.	Curtis.		
4·44	4·46	4·40	4·44	—	—	—	—	Michigan.	Miller.		
4·52	—	—	4·49	7·31	—	—	7·29	New Jersey.	Voorhees.	16·41	
4·47	—	—	4·45	7·30	—	—	7·23	New Jersey (Rutgers)	Cathcart.	16·33	
4·49	4·46	4·47	4·45	7·33	7·23	7·22	7·27	New York (Geneva)	Van Slyke.	—	
4·46	4·42	4·40	4·42	7·27	7·20	7·20	7·19	New York (Geneva)	Knisely.	16·17	
4·49	4·53	4·56	4·51	7·45	7·36	7·48	7·45	North Carolina.	Carpenter.	14·47	16·44
4·41	4·29	—	4·35	7·15	7·10	—	7·10	Pennsylvania.	Fields.	15·88	
4·52	4·38	—	4·56	7·34	7·04	—	—	U. S. Bio-Ch. Lab.	Emery.	—	
—	—	—	—	—	—	—	—	Department of Agricult.	Trescott,	16·34	16·36
4·47	4·49	4·48	4·47	7·32	7·24	7·29	7·26	West Virginia.	De Roode.		
4·42	4·38	4·45	4·31	7·24	7·14	7·28	7·05	Wisconsin.	Woll.		
4·47	4·43	4·46	4·44	7·27	7·18	7·26	7·21	Averages.			
4·52	4·53	4·56	4·56	7·45	7·36	7·48	7·45	Highest.			
4·41	4·29	4·40	4·31	7·15	7·04	7·14	7·05	Lowest.			
0·11	0·24	0·16	0·25	0·30	0·32	0·34	0·40	Difference.			

(4) The Ruffle method, applicable for all fertilizers containing nitrates.

(5) The soda-lime methods, not applicable for nitrates are all equally reliable in the hands of a careful analyst.

The Kjeldahl method is without any doubt an excellent method and especially adapted for station work, where the work can be suitably arranged to divide labor with a large quantity of samples of like character.

I find that most the station chemists work with this method, while on the other hand the trade chemists and most the chemists of manufacturers are using the soda-lime or Ruffle method, because, if one has to handle only a single sample at a time, one saves time in doing so.

Differences in low grade goods (two to three per cent. ammonia) should not be higher than 0·1 per cent., and in high grade never reach 0·5 per cent.

My experience during the last fifteen years has been that I never had material difference on this point with reliable trade or station chemists, but not so with chemists who instead of normal acid use diluted muriatic acid to absorb the ammonia and simply evaporate and weigh as muriate of ammonia. With such I never could agree.

It is hard to believe that at the present day such means should be applied by analytical chemists, but it has been the case until very recently, and is so doubtless yet in single instances.

On the whole the determination of nitrogen by the station chemists in the control of the work of fertilizers has given general satisfaction.

The most important part of a fertilizer material is without question phosphoric acid in its different forms, as water soluble, reverted or citrate of ammonia soluble, and insoluble, as well as total.

The determination of phosphoric acid is of such importance for the fertilizer trade that since the first meeting of the association strenuous efforts have been made to give concordant results.

How far the association has been successful is best shown by a recapitulation of the work done. I have gone back for five years, and now give you on accompanying tables the different reports in condensed form.

1888.

August 16, 17 and 18.

Three Samples Sent Out.

(*A*) South Carolina acid phosphate.

(*B*) English acid phosphate.

(*C*) Navassa acid phosphate laboratories have sent results.

	Moisture.	Soluble.	Reverted.	Insoluble.	Total.	Available.	Averages of Available Phosphoric Acid.
A	18·14	5·58	4·45	2·60	12·63	10·03	
	18·22	5·83	4·37	2·40	12·60	10·20	Mean, 10·45
	—	6·04	4·09	2·41	12·54	10·13	Highest, 11·51
	20·96	6·00	4·11	2·38	12·49	10·11	Lowest, 10·03
	17·25	6·10	4·65	2·35	13·10	10·75	
	18·10	6·15	5·36	2·17	13·68	11·51	Difference, 1·48
B	15·03	9·38	2·17	·43	11·98	11·55	
	17·07	9·48	2·24	·43	12·15	11·72	Mean, 11·31
	—	9·31	2·23	·20	11·74	11·54	Highest, 12·25
	16·15	9·34	2·41	·35	12·10	11·75	Lowest, 11·54
	15·65	9·35	2·90	·85	13·10	12·25	
	12·85	9·26	2·81	·50	12·57	12·07	Difference, 0·71
C	6·42	9·63	5·17	4·73	19·53	14·80	
	6·31	9·53	6·06	4·11	19·70	15·59	Mean, 15·31
	—	10·81	4·78	3·71	19·30	15·59	Highest, 15·59
	7·31	8·57	6·88	4·06	19·51	15·45	Lowest, 14·80
	5·40	8·60	6·10	4·25	19·25	15·00	
	7·45	8·78	6·68	4·32	10·78	15·96	Difference, 0·79

1889.

Five Samples Sent Out.

No. 1. Ground South Carolina phosphate.
No. 2. Ground tankage.
No. 3. Ammoniated super phosphate.
No. 4. Dissolved South Carolina phosphate.
No. 5. Dissolved Navassa phosphate.

AVERAGES.

	Number of Determinations.	Average.	Highest.	Lowest.	Difference.
Sample No. 1.					
Moisture,	17	·95	1 37	·76	·61
Phosphoric acid,	31	28·07	28·78	27·47	1·31
Sample No. 2.					
Moisture,	17	6·79	7·64	6·03	1·61
Phosphoric acid,	31	14·31	14·91	13·62	1·29
Sample No. 3.					
Moisture,	24	15·40	19·65	12·00	7·65
Soluble phosphoric acid,	32	7·11	8·57	6·00	2·57
Rev. " "	32	1·31	2·27	·80	1·47
Available " "	32	8·42	9·60	7·92	1·08
Insoluble " "	32	1·65	2·20	1·30	·90
Total " "	32	10·07	11·49	9·63	1·86
Sample No. 4.					
Moisture,	24	9·61	11·14	9·03	2·11
Soluble phosphoric acid,	32	10·88	11·51	8·67	2·84
Rev. " "	32	2·93	5·21	1·21	4·00
Available " "	32	13 81	14·29	12·37	1·92
Insoluble " "	32	1·95	2·81	1·28	1·53
Total " "	32	15·76	16·20	15·18	1·02
Sample No. 5.					
Moisture,	24	9·63	15·80	8·09	7·71
Soluble phosphoric acid,	32	7·52	10·04	6·00	4·04
Rev. " "	32	7·50	9·08	4·48	4·57
Available " "	32	15·11	15·90	14·52	1·38
Insoluble " "	32	3·40	3·86	2·93	·93
Total " "	32	18·51	19·19	18·06	1·15

1890.

Three Samples Sent Out.

No. 1. Guano.
No. 2. Acid phosphate.
No. 3 Ammoniated super phosphate.

AVERAGES.

	Number of Determinations.	Average	Highest.	Lowest.	Difference.
Sample No. 1.					
Moisture,	8	13·91	16·02	12·05	3·97
Total phosphoric acid,	15	22·43	22·90	21·81	1·09
Sample No. 2.					
Moisture,	10	16·35	17·82	15·20	2·62
Soluble phosphoric acid,	14	10·97	11·21	10·60	·55
Rev. " "	14	2·15	2·84	1·81	1·03
Available " "	15	13·15	13·64	12·64	1·00
Insoluble " "	15	1·81	2·16	1·53	·63
Total " "	15	14·96	15·48	14·38	1·10
Sample No. 3.					
Moisture,	8	10·99	13·65	10·18	3·47
Soluble phosphoric acid,	14	6·83	7·05	6·61	·44
Rev. " "	14	2·04	2·21	1·70	·51
Available " "	14	8·89	9·20	8 53	·67
Insoluble " "	14	1·76	2·02	1·57	·45
Total " "	14	10·67	11·04	10·15	·89

1891.

Three Samples Sent Out.

No. 1. A super phosphate.
No. 2. A complete fertilizer.
No. 3. A complete fertilizer.

(Containing cotton-seed meal and other substances difficult to oxidize.)

AVERAGES.

	Number of Determinations.	Average.	Highest.	Lowest.	Difference.
Sample No. 1.					
Moisture,	16	6·21	9·65	5·06	4·59
Soluble phosphoric acid,	21	9·26	9·81	8·77	1·04
Insoluble " "	21	4·75	5·83	4·19	1·64
Total " "	21	17·54	18· 0	16·96	1·34
Available " "	21	12·79	13·56	11·42	2·14
Sample No. 2.					
Moisture,	16	9·37	12·55	7·44	5·11
Soluble phosphoric acid,	22	6·46	6·87	5·80	1·07
Insoluble " "	22	1·30	2·15	0·87	1·28
Total " "	22	11·40	12·12	10·96	1·16
Available " "	22	10·10	10 37	9 51	0·86
Sample No. 3.					
Moisture,	15	6·15	11·47	4·38	7·09
Soluble phosphoric acid,	22	6·42	7·07	5·83	1·08
Insoluble " "	23	2·94	4·37	2·31	2·06
Total " "	23	12·21	13·40	11·57	1·83
Available " "	23	9·27	9·92	7·20	2·72

1892.

Four Samples Sent Out.

No. 1. Super phosphates containing Keystone (iron and alumina) phosphate.
No. 2. Regular phosphate.
No. 3. Dissolved steamed bones.
No. 4. Thomas slag.

AVERAGES.

	Number of Determinations.	Average.	Highest.	Lowest.	Difference.
Sample No. 1.					
Moisture,	22	—	—	—	—
Soluble phosphoric acid,	21	1·92	2·39	1·67	0·72
Insoluble " "	21	7·92	9·21	7·23	1·98
Total " "	23	17·12	17·73	16·27	0·46
Available " "	21	9 20	10·23	7·56	2·77
Sample No. 2.					
Moisture,	22	—	—	—	—
Soluble phosphoric acid,	21	2·52	3·10	2·14	0·96
Insoluble " "	21	5·16	5·80	3·37	2·43
Total " "	23	13·95	14·43	13·15	1·28
Available " "	21	8·79	10·58	8·03	2·55
Sample No. 3.					
Moisture,	21	—	—	—	—
Soluble phosphoric acid,	21	2·39	2·61	1·75	0·86
Insoluble " "	21	8·01	11·15	6·72	4·43
Total " "	23	21·94	22·72	21·22	1·50
Available " "	21	13·93	16·95	11·47	5·48
Sample No. 4.					
Moisture,	17	—	—	—	—
Soluble phosphoric acid,	3	—	—	—	—
Insoluble " "	17	11·53	13·28	10·11	3·17
Total " "	17	18·40	19·14	17·69	1·45
Available " "	17	6·87	9·96	4·94	5·02

RECAPITULATION.

Difference in available phosphoric acid in the samples sent out by the association.

1888	1·48	0·71	0·79	—
1889,	1·08	1·92	1·38	—
1890,	1·00	0·67	—	—
1891,	2·14	0·86	2·72	—
1892,	2·77	2·55	5·48	5·02

These figures speak for themselves and need no comment of mine. To say that they are satisfactory would be untrue. If you compare the results of the last five years, they apparently show a movement from bad to worse, but this is only apparently.

The samples of the first four years were mainly acid rocks, which are the easiest to handle, while the later reports are

FULL REPORT OF PROFESSOR LORD, COLUMBUS, O., AS GIVEN AT THE LAST MEETING.

Analyst.	Sample No. 1.					Sample No. 2.					Sample No. 3.					Sample No. 4.				
	Moisture.	Water Soluble Acid.	Insoluble.	Total.	Citrate Ammonia Soluble.	Moisture.	Water Soluble.	Insoluble.	Total.	Available.	Moisture.	Water Soluble.	Insoluble.	Total.	Available.	Moisture.	Water Soluble.	Insoluble.	Total.	Citrate Ammonia Soluble.
K. P. McElroy,	7·12	2·06	7·51	16·86	9·35	13·99	2·73	4·55	13·87	9·32	6·90	2·44	4·86	21·81	16·95	0·95	—	8·54	18·50	9·96
A. W. Fries,	3·84	2·11	7·94	17·63	9·69	11·00	2·81	5·52	14·43	8·91	6·43	2·61	11·15	22 62	11·47	0·89	—	11 98	18·61	6·63
H. E. Curtis,	3·41	1.67	9·09	17·65	8·56	9·67	2·14	5·80	14 30	8·50	6·66	2·09	8·95	22·24	13·29	0·94	—	12·25	18·59	6·39
R. E. Noble,	8·79	1·70	7·41	17·12	9·71	16·69	2·41	5·39	14·40	9·01	8·c8	2·26	9·50	22·44	12 94	1·46	0·07	10·27	18·54	8·27
S. Shiver,	3·78	—	—	17·24	—	10·05	—	—	13·91	—	—	—	—	21·76	—	0·99	—	—	18·17	—
R. N. Bracket,	—	—	—	17·21	—	—	—	—	13·93	—	—	—	—	21·58	—	—	—	—	18·20	—
J. S. Mong,	7·64	1·94	8·42	17·22	8·80	15·55	2·55	5·05	13·79	8·74	9·07	2·56	10·00	22·c0	12·10	1·20	—	13·28	18·22	4·94
T. B. Carpenter,	2·76	1·93	8·13	17·19	9·06	9·43	2·63	5·26	13·78	8·52	5·90	2·46	9·34	22·11	12·77	—	—	12·81	18·26	5·45
R. C. Kedzie,	6·12	1·90	7·48	16·94	9·46	14·47	2·55	5·18	13·81	8·63	7·42	2·52	8·80	21·49	12·69	0·83	—	12·44	18·17	5·73
L. G. Patterson,	3·42	1·79	8·26	17·53	9·27	9·64	2·25	5·67	14·20	8·53	6·40	2·41	5·24	21·93	16·69	0·99	—	10·34	18·37	9·43
W. R. Perkins,	3·39	1 93	8·35	17·55	9·20	9·59	2·28	5·73	14·15	8·42	6·34	2·31	5·55	21·87	16·32	0·89	—	11·07	18·37	7·30
H. Farrington,	3·31	1·92	7·23	16·72	9·49	9·90	2·56	4·89	13·94	9·05	6·55	2·56	6·14	22·03	15 89	—	—	10·11	18·61	8·50
F. W. Morse,	7·27	2·03	8·27	16·88	8·61	14·72	2·92	5·60	14·05	8·45	7·78	1·75	7·93	22·72	14·49	—	—	—	—	—
J. L. Hills,	3·36	1·74	6·81	16·27	9·46	10·76	2·31	4·08	13·15	9·07	6·55	2·07	6·82	20·92	14·10	0·47	0·03	9·97	17·69	7·72
R. J. Davidson,	3·34	1·89	6·66	17·20	10·54	9·69	2·59	5·06	14·04	8·98	6·40	2.49	7·41	22·06	14·65	—	—	12·38	18·34	5·96
J. A. Heberly,	13·06	2·13	8 42	16·76	8·34	20·73	2·80	5·57	13·60	8·03	13·53	2·45	10·39	22·15	11·76	1·54	—	—	18·21	—
C. S. Cathcart,	8·73	1·99	8·93	16·49	7·56	16·05	2·76	5·36	13·98	8·22	7·57	2·46	—	21·22	—	1·19	—	12·75	17·99	5·24
F. J. Fulkenbach,	8·11	1·68	6·64	16·87	10·23	16·05	2·42	3·37	13·95	10·58	7·73	2·23	8·14	21·31	13·17	1·21	—	—	18·62	—
N. W. Lord,	3·47	1·68	7·86	17·14	9·28	10·50	2·27	5·16	14·02	8·66	6·60	2·24	7·17	21·09	14·52	0·93	—	11·09	18·58	7·49
W. B. Viets,	7·80	1·92	7 67	17·00	9·33	15·85	2·68	4·79	13·93	9·14	7·60	2·30	8·69	21·79	13·10	1·22	—	13·10	18·47	5·37
R. B. Moore,	8·42	2·39	9·21	17·42	8·21	14·92	3·10	5·30	13·75	8·45	7·46	1·75	7·93	22·72	14·79	1·18	—	12·13	19·14	7·01
Delaware River Chemical Works,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
F. Bergami,	3·58	2·08	8·32	17·28	8·06	10·c0	2·56	5·63	14·00	8·37	6·53	2· 6	10·36	22·40	12·04	—	—	—	—	—
W. J. Williams,	3·10	2·11	7·68	17·73	10·05	9·40	2·75	5·44	14·34	8·89	6·25	2·56	6·72	22.59	15·87	0·75	0·26	10·43	18·82	8·39
Average,	—	1·92	7·92	17·12	9·20	—	2·57	5·16	13·95	8·79	—	2·39	8·01	21·99	13·93	—	—	11·53	18·40	6·87

The column has available phosphoric acid added to it.

composed of more complicated samples. This is especially the case with the samples of this year. [See full report of Professor Lord, table herewith.]

Sample No. 1 contained considerable Keystone phosphate, an iron alumina high grade phosphate, which has given rise to a great many controversies between chemists.

No. 2 is a regular mixture.

No. 3 is an incompletely dissolved bone, a material which always presents the greatest obstacles to proper filtration.

If you examine the results of No. 3 closely, with differences of over five per cent. available phosphoric acid, you might assume an extraordinary reason. We found in our laboratory that we had to quadruple the filtering paper before we could have a clear ammonia citrate solution, and are satisfied that the main reason for the extraordinary differences lay right there.

Sample No. 4, the Thomas slag, represents a new class of phosphates of lime, a quadribasic phosphate. It will take further study to ascertain if this class of products can be measured with the same rule as the bibasic phosphate in the common run of the fertilizers.

I have to call your attention to the great difference in the determination of moisture:

Sample No. 1.—Highest,	13·06
Lowest,	2·76
Difference,	10·30
Sample No. 2.—Highest,	20·13
Lowest,	9·40
Difference,	10 73
Sample No. 3.—Highest,	13·53
Lowest,	5·90
Difference,	8·63

The absolutely unsatisfactory results of the determination of moisture caused the association to discuss the reason for it at great length, and to the neglect of the main question of the shortcomings in the phosphoric acid determination. The brief time devoted to this year's report was

absorbed without ventilating the serious irregularities in the results obtained on phosphoric acid.

What can be the reason for the utter failure of last year's researches on phosphoric acid?

The samples sent out by Professor Lord were prepared with the utmost care, which insured absolute uniformity. Should we assume that the balances have not been rightly adjusted? Professor Payne charges manufacturers with using bricks for weights. Have some of the gentlemen made proportionate mistakes in analysis?

The failure to reach closer results in moisture shows very plainly that the necessary care has not been taken in the work, and when in the simplest determination of all analytical work such blunders are possible, we need not wonder at the differences in other more complicated determinations. Analytical work will always bear the stamp of individuality, and no absolute identical results can be obtained, but the differences should not rise above a narrow limit.

The proposition, made at the 1890 session of the society, by Mr. Charles Gibson, of Chicago, to change the official method of phosphoric acid determination by making the ammonia citrate solution slightly alkaline (p. 170), caused me to have a series of researches made in my laboratory to establish to a certainty if such an addition of ammonia would work detrimentally to the interest of acid phosphates derived from lime phosphates.

The result of numerous analyses has clearly demonstrated that it is not possible to show any difference between the results obtained with a neutral solution of citrate of ammonia and a slightly ammoniacal solution.

As an example, I will give only two analyses made with our own acid phosphate:

	Neutral Solution of Citrate of Ammonia.		*Ammoniacal Solution of Citrate, Specific Gravity 1·90, added to 100 cc. Citrate of Ammonia.*	
	No. 1.	*No. 2.*	*No. 1.*	*No. 2.*
Total available phosphoric acid, .	12·66	13·34	12·66	13·51
Phosphoric acid, ...	2·62	2·24	2·62	2·17
Total phosphoric acid, ...	15·28	15·66	15·28	15·68

Sample No. 1 is absolutely identical in its results.

Sample No. 2 shows only a difference of 0·07.

Being satisfied that in the change to a slight ammoniacal solution of citrate of ammonia from the strict neutral no direct harm will be done to the valuation of phosphates derived from phosphates of lime, our curiosity was aroused to see what acidity would show in the same material.

	Sample No. 1.	*Sample No. 2.*
	0·75 Gramme Citric Acid to 100 of Citrate of Ammonia.	*1·00 Gramme Citric Acid to 100 of Citrate of Ammonia.*
Total available phosphoric acid, ...	12·85	13·70
Insoluble phosphoric acid, ...	2·43	1·98
Total phosphoric acid, ...	15·28	15·63
Increase of available phosphoric acid,	0·19	0·29

The increase of the available phosphoric acid under such strong acidity as is produced by the addition of 0·75 grm. and 1 grm. citric acid to 100 of the normal citrate of ammonia solution is only 0·19 and 0·29 per centum, a variation which is generally conceded to be permissible in analytical work, as shown by all previous reports of the society, proves to our satisfaction that the claim so often made, that the change of the ammonia citrate solution from neutral to acid causes great differences in the results of phosphoric acid determinations is not borne out by careful researches.

In order to test the stability of the citrate of ammonia solution, my assistant, Mr. Bergami, prepared, October, 1890, a bottle of normal citrate of ammonia solution, which has been kept in one-half litre bottles, glass stoppered, in a closet, and from time to time tested; the last test was made a few months ago, and proved the absolute neutrality of the solution.

In order to prevent the formation of fungus in the solution, we have, during the last few years, added to a quantity of about two litres, 0·1 gramme of salicylic acid. Without impairing the nature of the neutral solution in the least, this minimum quantity has successfully prevented the

formation of the fungus and thereby destroyed the possibility of changing the neutral condition to acidity.

This proves to our satisfaction that the claim of unreliability of the citrate of ammonia solution (p. 179, 180, Rep. of 1890) is not well founded, if all necessary precautions are taken in preparing the solution, and keeping the same in not too large bottles well stoppered, as recommended long ago by Prof. Paul Wagner, of Darmstadt.

The claim, made by the advocates of the ammoniacal citrate of ammonia solution, that the slightest acidity will impair the correctness of the analysis in alumina phosphates or producers, was almost incredible, and the publication of the analysis by Mr. Williams, pp. 178–179 of the last report, proves that the fault must lie somewhere else and not in the normal neutral solution of citrate of ammonia.

There are numerous other points in the determination of available phosphoric acid, which might let in small variations; temperature variations in the water-bath, the washing of the portion insoluble in citrate of ammonia, may influence the results, but I do not hesitate a moment to say that if the official methods were carefully executed by a competent analyst, such discrepancies would not be possible, even in case of iron and alumina phosphate. The Association of Official Agricultural Chemists has given us the very best methods for the investigation of fertilizers—methods that are accepted, with a single exception, over the whole United States (New Jersey alone determines available phosphoric acid at a temperature of 40° C., instead of 65° C., falling thereby one-half per cent. lower in average result). The association has now the imperative duty to establish the fact, that it only needs careful and competent workers to make such results as are laid before you to-night, absolutely impossible.

The fact that differences of two per cent. and six per cent. insoluble phosphoric acid are possible in test samples prepared with care for the very purpose of a trial of methods is calculated to upset all confidence in the so-called control work of the Agricultural Experiment Stations.

The difference in results as shown by the reports on phosphoric acid has very serious consequences for the fertilizer trade at large.

The stations have assumed the roll of arbitrators between buyer and seller. They have gone further, and act as advisers for the farmer by establishing valuations based on chemical analysis.

I will not ventilate to-night the real value of these valuations, but take facts as I find them.

The market valuation as adopted by the Eastern and Middle States is, I believe, seven and one-half or eight cents, per unit available phosphate. Supposing it is eight cents, and take sample No. 3.

The first analyst makes available phosphoric acid

16·95 per cent. × 8
135·60 × 20
$27·12 valuation per 2,000 pounds.

The second analyst makes available phosphoric acid

$$\frac{11{\cdot}47 \times 8}{91{\cdot}76 \times 20}$$

$18.35 per ton.

Or difference in valuation of $8.67 per ton. On which analysis shall we buy? is a question which readily will come to the farmer.

Supposing Sample No. 3 represents a brand guaranteed thirteen per cent. of available phosphoric acid.

In several Southern States a falling off of ten per cent. of the guaranteed analysis makes the goods liable to confiscation.

In this case two analyses of State chemists, the second and sixteenth, will brand the goods as to be condemned under the law. But if the manufacturer should have been misled by one of the numerous high results, and put his guarantee high, he made himself a criminal in half the States of which you have the returns before you.

As long as the results of chemical analysis are so uncertain, as shown by the work of the official association

under the most favorable examination, the public should be extremely careful in forming judgment on a single report of a station if the same should show a remarkable difference between guaranty and results.

The fertilizer trade has been maltreated by suspicion, perhaps, more than any other trade. The trade has been surrounded by an endless chain of different State laws; some of which are in conflict with the Constitution of the United States, and these laws are, to a great extent, based on the idea of the infallibility of chemical control. How infallible the States' control can be, I have shown you to-night by the work presented.

The work of the Association of Agricultural Chemists deserves to be highly commended for the good it has done, but the association must go further, before it can hope to be recognized as the arbitrator in the fertilizer trade.

The association should influence State legislation through its members, to the end that the laws regulating the trade shall be made to conform with the practical results of their work.

The influence of the association should be exerted likewise in the legislation of New Jersey, to effect the repeal of an antiquated dictum in analytical work erroneously sanctioned by law; and in the Southern States, where unjust laws have been based on the belief in the infallibility of control work of the agricultural station.

DISCUSSION.

DR. WM. J. WILLIAMS.—I have listened with much pleasure to Dr. Terne's paper on the discrepancies found in the analyses of different official chemists when engaged in analyzing the same goods, and not merely the same goods, but actually the same (divided) sample of the same goods.

Dr. Terne has called attention more particularly to the analyses of bone—raw and partially dissolved. Similar cases have arisen in my experience, with even greater discrepancies in dealing with our Keystone concentrated phosphate, a concentrated phosphate of iron and alumina. While several chemists of high standing in the profession,

both official and non-official chemists, gave the quantity of available phosphoric acid fairly closely, as, for instance:

Per Cent.	*Per Cent.*
30·60	30·25
30·87	30·35
31·02	30·37
32·35	

others could only get 25·22 per cent. and others 20·31, 19·40 and 19·70 per cent. The last three especially show a difference beyond any reasonable limit.

Now, as the verdict of an "official" chemist is final in his State, or at any rate his figures are published and become generally known, such discrepancies work great injustice to manufacturers, and if the official chemists could make some change in the "official" method, whereby these discrepancies could be minimized, it would be a great advantage to all concerned.

The question has already been discussed by the official chemists in convention, but up to this time no solution of the difficulty has been arrived at.

One point suggested was that a slight acidity or alkalinity of the "official" neutral ammonium citrate solution caused the greater part of these differences. So far as my own investigations go (made since the convention above referred to), I do *not* find that a *slight* acidity or alkalinity of the solution makes any appreciable difference greater than the ordinary errors of analysis.

I find, however, that a slight difference in the time of exposure of the material at 65° C. does make considerable differences in the results. The instructions now given read: "Cork the flask securely and place it in a water-bath, the water of which stands at 65° C. * * * Raising the temperature as rapidly as practicable to 65° C., which is subsequently maintained, digest for *thirty* minutes *from the instant of insertion*," etc. Up to 1887, I think, or possibly 1888, the instructions were to this effect: Place the flask in a water-bath, the temperature of the water in which is 65° C., raise the contents of the flask up to 65° C. as rapidly as possible, and *maintain at that temperature* for thirty minutes. (I cannot

give at the moment the exact words, but that is the substance.)

Now, it would appear that this difference of instructions should not be of much moment, as all using the official method are working under the same instructions, and in all cases the time of exposure to a temperature of 65° C. is of equal duration, but such is not actually the case. Under the earlier instructions the contents of the flask were uniformily exposed to a temperature of 65° C. for thirty minutes; and under these conditions these great discrepancies in results appeared neither so frequently nor to so great an extent. But when the instructions were changed to the present form, viz: "Digest for thirty minutes from the instant of insertion," then they became greater and more frequent.

This, I think, is due to the differences in the conditions to which the material is exposed in the water-bath; that is to say, the solution of exposed neutral ammonium citrate reaches 65° C. much quicker in some cases than others. I made inquiries from many chemists on this point, *i. e.*, how long it required for the solution in the flasks to reach the temperature of 65° C. after insertion in the water-bath. The time varied from three to nine or ten minutes. That is to say, the time during which the material was exposed to a temperature of 65° C. varied from twenty to twenty-seven minutes, a variation which is, I believe, sufficient to account for the greater part of the discrepancies. This variation in time can be ascribed to many causes, *e. g.*, size of bath, depth of water, quantity of heat used, thickness or shape of flasks or other vessel, etc., and it would appear impossible to produce uniformity of conditions, and, therefore, uniformity of results under the present directions. I think, however, if the instructions were modified, so as to secure the exposure of the material to a temperature of 65° C. for a uniform fixed time of thirty minutes, as was done under the original form of instructions, instead of to a variable time ranging from twenty to twenty-seven minutes, as under the present form of instructions, that the results would be far more uniform and would be far more satisfactory to all concerned.

OBSERVATIONS ON FERRO-TUNGSTEN.

By Wm H. Wahl.

[*Read at the stated meeting of the Chemical Section, held November 15, 1892.*]

In the course of an investigation carried on during the past two years by the writer, in conjunction with Dr. William H. Greene, with the object in view of producing pure ferro-alloys, we made a number of experiments with ferro-tungsten.

These tungsten alloys exhibited similar physical properties possessing considerable hardness and toughness, an extremely fine crystalline texture, with a fracture resembling that of tool-steel, and a specific gravity ranging between 9·3 and 10·14.

Some of the fractures, however, exhibited the fact that the alloy was not entirely homogeneous, disclosing under the glass and in places to the eye, the presence of what are apparently smooth cleavages of imperfect crystals scattered through the finely-crystalline matrix of the alloy. The specimen shown you will illustrate my statement.

A sample of the alloy of 10·14 specific gravity was analyzed at my suggestion, by Mr. J. F. de Benneville in the laboratory of Dr. Genth. The result of the analysis exhibited a very high percentage of tungsten in the sample, and its behavior towards liquid and fused solvents proved the interesting fact that a large proportion of the tungsten was present in the uncombined condition, as metallic tungsten, crystallized in the matrix of the alloy. The facts upon which Mr. de Benneville has founded this observation will appear in the following extract from a letter describing briefly the method pursued in his analytical work.

"*Aqua regia* attacked it, although not energetically, and by decanting and adding fresh portions of acid from time to time a residue was obtained which resisted further action by acids, or by fusion with Na_2CO_3 and KNO_3. It was a heavy, black, pulverulent substance, and in its negative

action towards solvents answered to tungsten, which I took it to be. It gave 22·54 per cent. of the original material. A second portion of the material (powdered in a steel mortar) was fused with a mixture of Na_2CO_3 and KNO_3, lixiviated and the residue weighed. This was fused again and the residue weighed, the second weighing being practically the same, and yielding 22·80 per cent. of the original material, using strong HCl (1·20 Sp. gr.) in successive portions, decanting, igniting the residue and treating again with acid, gave me 21·74 per cent."

The foregoing extract appears fully to justify the conclusion that the undissolved residue represents the metallic tungsten present in the alloy in the uncombined state.

The composition of the metal analyzed by Mr. de Benneville is as follows:

	Per Cent.
C,	0·85
P,	0·041
Si,	0·14
Mn,	trace
Fe,	42·28
W (metal),	22·54
W (alloy),	34·35
	100·201

A study of these figures reveals another interesting fact to which I desire to call your attention.

Taking the figures of the iron and combined tungsten (42·28 : 34·35) and calculating the percentage of tungsten which this ratio represents, we obtain 44·82 per cent. tungsten. A calculation shows also that the figures representing the compound Fe_4W are almost identical with the ratio above-named, to-wit:

Fe_4W Found.	*Fe_4W By Theory.*	*Difference.*
Fe, 55·18 per cent.	Fe, 54·91 per cent.	
W, 44·82 "	W, 45·09 "	— 0·27
100·00	100·00	

The conclusion would seem to be justified by the facts above noted, that the saturation point of iron for tungsten

is represented by the ratio exhibited in the compound Fe_4W, and that any excess of tungsten, above this ratio, present in a tungsten iron will remain uncombined.

I wish to express this statement as *probably* the correct interpretation of the facts, for it is hazardous to make a generalization of this kind on the results of a single analysis.

It may be interesting to note in conclusion that Howe, in his "Metallurgy of Steel," refers to several cases of ferro-tungsten indicating the composition Fe_5W, and that the works on metallurgy as a rule accept without question the dictum that iron and tungsten will unite in all proportions. In the light of the facts given in this paper, this last statement requires qualification.

PROCEEDINGS.

[*Stated meeting held Tuesday, December 20, 1892.*]

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, December 20, 1892.

Dr. Wm. H. Wahl, President, in the chair.

The special business of the evening being the election of officers for the coming year, this matter was considered first.

Letters from the various candidates were read, accepting or declining their nominations made at the November meeting. The gentlemen accepting nominations were Dr. Wm. H. Greene for President, Mr. Henry Bower and Dr. D. K. Tuttle for Vice-Presidents, two to be elected.

The nominees for the remaining offices were the present incumbents, Wm. C. Day, Secretary; Dr. H. W. Jayne, Treasurer, and Dr. Wm. H. Wahl, Conservator.

The Secretary was directed to cast the vote of the Section for all the candidates above-named.

Mr. H. Pemberton, Jr., nominated Mr. Geo. P. Tucker, of the Patent Office, Washington, D. C., and Dr. Wahl nominated Mr. W. J. Williams, of Wilmington, Del.

The Committee on Admission having considered the candidates presented, declared them elected members of the Section.

The annual report of the Treasurer was read and referred to the Auditing Committee, who examined the accounts, and the report was accepted.

The Secretary's annual report was read and accepted.

The committee in charge of the reception tendered, on the 5th inst., to Dr. H. W. Wiley, of Washington, D. C., made a report, which was accepted with a vote of thanks and the committee was discharged.

The Secretary suggested that the interest of our meetings might be increased if during the year we could secure a limited number of papers, giving in condensed form an account of the development of certain subjects either of technical or purely scientific import, thereby showing the present state of knowledge of those subjects. At the suggestion of Dr. Jayne, the matter was referred to a committee to be named by the Chair to consider the advisability of the suggestion and to formulate a plan for carrying it out. The President appointed Dr. Wm. H. Greene, Mr. H. Pemberton, Jr., and

the Secretary members of this committee, with instructions to report at the January meeting.

Dr. S. C. Hooker read a paper on "Di-brom β-Lapachone: its Preparation and Properties." The paper was the joint production of Dr. Hooker and Mr. A. D. Gray.

Dr. Hooker read also an abstract from the "Annual Report of the Secretary of Internal Affairs of Pennsylvania, Department of Industrial Statistics." This abstract treated of the progress of the process of sugar refining as at present conducted at the Franklin Sugar Refinery of Philadelphia. The article showed clearly and in detail the high state of perfection to which the sugar refining industry has been brought.

Both papers called forth considerable discussion from the members present.

Specimens of the substances discussed in both papers were presented for inspection.

A paper on "Artesian Wells as a Water Supply for Philadelphia," by Prof. O. C. S. Carter, of the Central High School of Philadelphia, was submitted by Dr. Greene; it was read by title and referred for publication.

The Section then adjourned. WM. C. DAY, *Secretary.*

THE DEPOSITS OF NATIVE SODA, NEAR LARAMIE, WYOMING.

BY H. PEMBERTON, JR., AND GEO. P. TUCKER.

[*Read at the stated meeting of the Chemical Section, November 15, 1892.*]

Previous to the Civil War, and at a time when the line of civilization extended as far only as the Mississippi River, very little was known of the part of the United States west of that limit. A vast region now comprising many large States was described in the geographies of the day as "the great American Desert." It constituted a part of the prairies or plains, so often mentioned in Cooper's novels. And while the prairies, as a general rule (and particularly in elevations not much above sea-level), are composed of a fertile and rich soil, their character changes as the approach is made to the Rocky Mountains, and when an elevation of 7,000 feet is reached as in Wyoming, the soil and climate resemble somewhat the soil and climate of Nevada and other parts of the Great Basin. On this high Wyoming

plateau, particularly in the neighborhood of the town of Laramie, one drives for miles over a perfectly flat country, with nothing but some distant hills to break the wide circle of the horizon—not even a single tree. A little thin grass grows in the gravelly soil, but no other form of vegetation, except when aided by irrigation. The region is nearly rainless, the relative humidity quite low, and all conditions favorable to the formation of the saline deposits peculiar to this portion of the United States.

About fourteen miles southwest of Laramie, there exists a deposit of sulphate of soda, such deposits are locally known as "lakes." The deposit in question is composed of three of these lakes lying within a stone's throw of one another. They have a total area of about sixty-five acres, the local names of the three being the Big Lake, the Track Lake and the Red Lake. They are the property of the Union Pacific Railroad Company, are connected by a branch of that road with the main line at Laramie, and are generally known as the Union Pacific Lakes.

In these lakes the sulphate of soda occurs in two bodies or layers. The lower part constituting the great bulk of the deposit, is a mass of crystals of a faint greenish color, mixed with a considerable amount of black slimy mud. It is known as the "solid soda." We give an analysis of this below.

ANALYSIS OF SOLID SODA IMMEDIATELY UNDER THE TOP LAYER OF WHITE SULPHATE OF SODA ON RED LAKE AND TRACK LAKE (U. P. LAKES).

	Anhydrous. Per Cent.	*Crystallized. Per Cent.*
Na_2SO_4,	36·00	81·63
$CaSO_4$,	1·45	1·82
$MgCl_2$,	·77	1·64
NaCl,	·21	·21
	38·43	85·30
Insoluble residue (at 100° C.),		13·86
		99·16

Total chloride calculated as NaCl equals 1·16 per cent.

This calculated on 100 parts anhydrous: Na_2SO_4 equals 3·22 per cent. NaCl.

This solid soda is stated to have a depth of some twenty or thirty feet. Borings were made a number of years ago under the direction of the Union Pacific Railroad agents, but all attempts to obtain the results of the same were futile, as the records have been mislaid or lost. There is nothing to prove that the depth is not shallower than stated above.

Above the solid soda occurs the superficial layer of *pure white crystallized sulphate of soda*. This is formed by solution in water of the upper part of the lower body—the crystals being deposited by evaporation or by cooling, or by the two combined. A little rain in the spring and autumn furnishes this water, as do also innumerable small, sluggishly flowing springs present in all the lakes. But on account of the dry air of this arid region, the surface is generally dry or nearly so, and in midsummer the white clouds of efflorescent sulphate that are whirled up by the everblowing winds of Wyoming can be seen for miles. Even should there be a little water present, there is no difficulty in gathering the crystals by the train load. The spring, however, is the worst season of the year, on account of the warm weather and of the rains—conditions unfavorable to the formation of crystals. The layer of this white sulphate is from three to twelve inches in thickness. When the crystals are removed, the part laid bare is soon replenished by a new crop.

The following is an analysis of the purest of this white sulphate of soda, calculated upon an anhydrous basis; that being the condition, of course, in which it would be used.

Na_2SO_4,	99·73
$MgCl_2$,	·26
Insoluble,	trace
	99·99

Several hundred tons of this have been shipped by the railroad to the works at Laramie City. The plant there for dehydrating the crystals is not of the best, and the long exposure to the dust and smoke of the fire gases in the evaporation—and again in the calcining—introduces more

or less impurity into the finished calcined sulphate of soda. The following is an analysis of the latter:

	Finished Calcined Sulphate of Soda. (From U. P. Lakes.)	
Na_2SO_4,	95·80	soluble in water.
$CaSO_4$,	·76	soluble in water.
NaCl,	1·84	soluble in water.
Ignition,	·19	insoluble in water.
SiO_2,	1·48	insoluble in water.
Fe_2O_3,	·06	insoluble in water.
Al_2O_3,	·31	insoluble in water.
CaO,	·20	insoluble in water.
MgO,	·44	insoluble in water.
	101·08	

This analysis represents the general run of the sulphate, as manufactured in Laramie. The sample was taken from a carload lot sold to the Wyoming Glass Company. It contains only a trace of iron, and, of course, no free acid.

At the time when we examined these lakes, in 1888, they were entirely under water. An irrigating canal—or "ditch"—had been located within a half mile of them, the water from which had gradually collected to the extent of several feet in the lakes. The course of the canal has since been changed, and the lakes are again in about their normal condition.

Samples of this water were collected by us, and analyzed as giving a very fair idea of the average composition of the deposits. The ingredients are calculated to the anhydrous condition. The last item, it will be noticed, is given as anhydrous borax, $Na_2B_4O_7$. It represents the results of titration with standard acid, using methyl orange as an indicator. It may be noted that, on account of the lime salts present in solution, alkaline carbonates and phosphates must be absent, and direct test proved the absence of soluble silicates. We have noticed the same titration reaction (if we may so call it) in a sample of sulphate of soda from a deposit near Rawlins, Wyoming, and, in general, it may be stated that the character of the climate, soil, and formation in Wyoming is very similar to that of such parts of the Pacific Slope as are known to contain deposits of borax.

WATER FROM BIG LAKE (U. P. LAKES).

Density = 9¾° Tw. (= 1·0487 sp. gr.)

10 cc. contains:

	Grams.	*Per Cent.*
Na_2SO_4,	0·4490	= 81·43
$CaSO_4$,	0·0175	= 3·17
$MgSO_4$,	0·0060	= 1·09
$MgCl_2$,	0·0643	= 11·66
$Na_2B_4O_7$?	0·0146	= 2·65
Total solids,	0·5514	100·00
(Total solids by evaporation,	0·5417)	

One cubic foot contains $6\frac{36}{100}$ pounds of pure crystallized sulphate of soda.

WATER FROM TRACK LAKE (U. P. LAKES).

Density = 14½° Tw. (= 1·0725 sp. gr.)

10 cc. contains:

	Grams.	*Per Cent.*
Na_2SO_4,	0·7563	= 92·23
$CaSO_4$,	0·0146	= 1·79
$MgSO_4$,	0·0070	= ·85
$MgCl_2$,	0·0300	= 3·66
$Na_2B_4O_7$?	0·0121	= 1·47
Total solids,	0·8200	100·00
Total solids by evaporation,	0·8240	

One cubic foot of this water contains $10\frac{72}{100}$ pounds of pure crystallized sulphate of soda.

WATER FROM RED LAKE (U. P. LAKES).

Density = 17¾° Tw. (= 1·0887 sp. gr.)

10 cc. contains:

	Grams.	*Per Cent.*
Na_2SO_4,	0·9307	= 91·77
$CaSO_4$,	0·0201	= 1·98
$MgSO_4$.	0·0143	= 1·41
$MgCl_2$,	0·0416	= 4·10
$Na_2B_4O_7$?	0·0075	= ·74
Total solids,	1·0142	100·00
Total solids by evaporation,	1·0320	

One cubic foot of this water contains $13\frac{19}{100}$ pounds of pure crystallized sulphate of soda.

We give, also, below analysis of sulphate of soda from lakes controlled by Col. S. W. Downey, of Laramie. Of these deposits we know but little other than that they are situated about twenty-five miles southwest of Laramie, and as indicated by the analyses, are contaminated by lime and

magnesia salts to a considerable degree. Both analyses were made on samples previously calcined.

	S. W. Downey's Wilcox Lake.	*S. W. Downey's Red Soda.*
Na_2SO_4,	43·12	69·55
$MgSO_4$,	41·70	6·75
$CaSO_4$,	—	11·24
NaCl,	·20	1·01
Ignition,	·32	·33
Insoluble,	16·15	10·50
	101·49	99·38

From a commercial standpoint these Wyoming deposits are interesting, inasmuch as they furnish cheaply and in large quantities quite a pure grade of sulphate of soda. This sulphate being free from iron, and also, of course, from free acid, is well adapted to use in the manufacture of glass. Freight rates from the East are in its favor and allow a price that should yield a fair profit. Attempts have been made at Laramie on quite an elaborate scale, to manufacture soda ash and caustic by the Leblanc process. These efforts were not remunerative.

ARTESIAN WELLS AS A WATER SUPPLY FOR PHILADELPHIA.

By Oscar C. S. Carter,
Prof. Geology and Mineralogy, Central High School, Philadelphia.

[*Read by title, December 20, 1892.*]

The long-continued drought of the summer of 1892 was unusually severe, the rise of even a couple of inches was eagerly noted in the city reservoirs and frequent warnings were given to use no more water than was absolutely necessary. The frequent low-water mark of the Schuylkill and its well-known impure condition in dry seasons are strong reasons for causing us to seek a new supply of pure and wholesome water. Even if artesian wells will not entirely take the place of the Schuylkill they will at least prove a powerful aid, both in quality and quantity. After keeping a complete record of more than twenty wells that have been drilled recently in Montgomery, Philadelphia, Chester and Delaware Counties I would strongly urge a trial of artesian water. The two main points to consider are the purity and the quantity. First, as regards purity, it is a well-known fact that water which has filtered through from 200 to 500 feet of rocky strata is practically free from organic and all deleterious matter. It is never muddy or dirty but always clear and free from sediment. The wells are cased or lined with iron pipe sometimes to a depth of 100 feet. This effectually shuts off any surface drainage, so that it would be impossible for disease germs which are common in river water to reach these deep wells. As a rule artesian water is pure, sparkling and wholesome. It sometimes happens when a well is newly drilled that the water may have a slight mineral taste, due to the salts of lime, magnesia, potash and iron dissolved by being in contact with the rocks for a long time, or it may be a trifle hard. This, however, from experience, we know, is rarely the case, and it soon disappears when the water has been pumped for a certain time because new water filters in and takes its place. One

instance in particular may be given in this city where the water was used for boilers and became quite soft on continuous pumping. The water of nearly all the wells drilled in this vicinity is in constant use for drinking water and has proved satisfactory.

It will be urged by many, no doubt, that the supply derived from artesian wells is insignificant and, as a rule, that it is difficult to find water-bearing strata in this vicinity. Such, however, is not the case. Nearly all the rocky strata within an area of twenty miles of Philadelphia will yield water whether the rocks be mica schist, syenite sandstone or limestone. Occasionally you may find a locality that is barren, but this is rarely the case.

A comparison of the wells drilled in Europe and in this vicinity may be of interest. The wells drilled abroad have furnished an abundance of water for the supply of cities. At Grenelle, near Paris, a well was drilled to a depth of 1,798 feet, when the water stratum was reached a column of water rose in the well that furnished 36,000 gallons per hour, the entire water supply of a suburb of Paris. The well drilled at Passy has a diameter of 2 feet 4 inches and is 1,900 feet deep. From this a column of water rose to the height of fifty-four feet and furnished 5,582,000 gallons per day. Many artesian wells have been drilled in the chalk strata around London. One well alone, at Chadwell near Ware, yielded London over 4,500,000 gallons per day toward its water supply.

The Kentish Town Water Works have a well nearly 1,000 feet deep. It is said there were two wells drilled at Chicago each five inches in diameter, one 1,000 feet and the other 700 feet deep, which furnished 800,000 gallons daily to the water supply. A well of three-inch bore and 2,000 feet deep was drilled at Louisville, Ky., and furnished nearly as much water as the deep well near Paris.

It may truthfully be urged that the geological formation of Philadelphia and vicinity is different from that of Paris and London, but the records of a few wells drilled in this locality will show that we have prolific water-bearing strata in Southeastern Pennsylvania. A well was drilled by the

Oriental Bath Company, at 1104 Walnut Street, Philadelphia, through sixty-six feet of clay and 200 feet of mica schist and gneiss rock. It yields 6,000 gallons per hour and rises to within twenty-eight feet of the surface. The Pennsylvania Railroad drilled ten shallow wells near Radnor within a space of an acre to supply the water tanks and a pumping station. These wells when connected and tested by continuous pumping yielded 288,000 gallons per day. Deep wells at Radnor do not give much water. At Lansdale, along the North Pennsylvania Railroad, a few miles north of Philadelphia, there is no water supply except that derived from an artesian well. This well was drilled to a depth of 611 feet, and is cased or lined with iron pipe to a depth of 259 feet; with an improved pump, it could give 200 gallons per minute or 288,000 gallons per day. The supply is said to be practically inexhaustible. Lansdale is not a particularly good locality for water except at a great depth, because the clay slate, shale and sandstone are tightly packed and the water soaks slowly between the bed planes. The borough of Jenkintown is supplied with artesian water and is in the same belt of mica schist rock as Philadelphia wells. One well is 324 feet deep, the other is 349 feet deep. They will each yield 9,000 gallons per hour, and not only supply Jenkintown with water, but also the surrounding twenty villages for a distance of three miles. The water is soft. Artesian wells drilled in the mesozoic or new red sandstone at Newark, N. J., have yielded an abundance of water. Three wells of six-inch bore, and each less than 100 feet in depth, flowed at the rate of 250,000 gallons each per day. Another deeper well in the same city is yielding 800,000 gallons per day. This is a favorable locality, because the water-bearing stratum underlies a thick bed of clay. Wells drilled in the same belt of mesozoic sandstone at Norristown, Pa., yield over 3,000 gallons per hour with small pumps. Many other instances of prolific wells, such as those at Atlantic City and Ocean Grove, can be given; but enough has been said to show that we have water-bearing strata. Of course, it would be impossible to supply a city the size of Philadelphia wholly with artesian water, but in seasons of long-

continued draught, such as the summer of 1892, when the rise of even a couple of inches in the reservoirs was eagerly noted, artesian wells would be an enormous gain. In a deep well, when a water crevice is struck near the bottom in drilling, it can be widened and the supply of water enormously increased by exploding nitro-glycerine in the wells in precisely the same manner that it is employed in the oil regions. Tin canisters containing the proper amount are lowered and exploded by means of electricity. The explosion widens the bottom water crevices.

The city of Philadelphia is underlaid with an immense deposit of clay which artesian borings have shown is fifty feet in thickness, and in many parts of the city much deeper. Clay is impervious to water, and this great clay bed checks to a great extent, although not wholly, the filtration of surface drainage. It must not be thought for an instant that the clay is a perfect barrier and wholly prevents the surface water from getting to the mica schist rocks beneath, because instances can be given of surface water getting below and showing on analysis. One fact then cannot be too strongly emphasized, artesian wells must be thoroughly cased with iron pipe from the surface, the deeper the better. When they are properly cased for 100 feet or more there is little if any danger from surface contamination. When the well is finished it should be pumped for a couple of hours, and the next day a sample taken for chemical analysis. If any trace of surface contamination is shown, the casing should be driven deeper until analysis proves the water to be perfectly pure. These precautions are only necessary in large cities and towns. Artesian wells drilled in the country will always yield pure water. A series of artesian wells drilled in Fairmount Park, some distance out, would yield an abundance of pure and wholesome water, which would be free from surface contamination of any kind.

A series drilled near the new reservoir at Roxborough would give the purest water. When artesian wells are drilled in solid rock in the country, it is not necessary always to line them with iron pipe, as a hard compact rock will remain open from top to bottom when once drilled.

ANNUAL REPORT OF THE CHEMICAL SECTION OF THE FRANKLIN INSTITUTE.

(For the Year 1892.)

JANUARY 1, 1893.

Mr. Joseph M. Wilson, President of the Franklin Institute:

SIR:—I have the honor to submit the following report of the proceedings of the Chemical Section for the year 1892:

Although no great advances over the results of the past few years have been made, the Section is in its usual prosperous condition, and as shown by the demand for the printed copies of its proceedings in other cities, as well as in Philadelphia, its work appears to be appreciated.

The officers for the past year have been as follows:

President,	DR. WM. H. WAHL.
Vice-Presidents,	DR. E. F. SMITH, DR. WM. H. GREENE.
Secretary,	DR. WM. C. DAY.
Treasurer,	DR. H. W. JAYNE.
Conservator,	DR. WM. H. WAHL.

Stated meetings have been held as required by the by-laws, on the third Tuesday of each month, excepting July and August.

Membership.—The number of members on the treasurer's books at the beginning of the year was seventy-nine; since that time three new members have been elected, four have resigned, one has died and one was dropped for non-payment of dues, making the present membership seventy-seven.

Finances.—The recently submitted report of the treasurer shows cash on hand at the beginning of the year $131.85, received during the year, $136; expenditures amounted to $193.79, thus leaving on hand a balance of $74.16.

The following is a list of the papers which have been read before the Section at its ten regular meetings.

"Analysis of Eggio," by Mr. Charles S. Boyer.

"A New Form of Gas-measuring Apparatus," by Mr. H. Pemberton, Jr.

"A Rapid Method for the Determination of Carbonic Acid Gas," by Mr. H. Pemberton, Jr.

"The Electrolytic Deposition of Aluminum," by Dr. Wm. H. Wahl.

"The Composition of the Explosive Copper and Silver Compounds of Acetylene," by Dr. H. Keiser.

"Notes on Iron in Bone-black," by Dr. Bruno Terne.

"Derivatives of Lapachic Acid," by Dr. S. C. Hooker.

"Chestnut Bark Tannin," by Prof. Henry Trimble.

"The Influence of Bottles upon Wines," by Mr. Charles E. Ronaldson.

"An Improved Method of Determining Small Percentages of Gold and Silver in Base Metal," by Mr. M. Cabell Whitehead.

"Armor-plate Tests at Indian Head Proving Ground," by Mr. F. Lynwood Garrison.

"On the Composition of the Liquid Ammonia of the Trade and How to Manufacture Liquid Ammonia of 99·995 Per Cent.," by Dr. Hans von Strombeck.

"Account of the Meeting of the Association of Agricultural Chemists at Washington," by Dr. Bruno Terne.

"The Washing of a Southern Coal: Comparison of Laboratory Results with those of Actual Washing Test," by Mr. Geo. W. Whyte.

"A Lilac Color from Extract of Chestnut," by Mr. T. C. Palmer.

"Deposits of Native Soda near Laramie, Wyoming," by Mr. H. Pemberton, Jr., and Mr. Geo. P. Tucker.

"Observations on Ferro-tungsten," by Dr. Wm. H. Wahl.

"Dibrom β-lapachone: Its Preparation and Properties," by Dr. S. C. Hooker and Mr. A. D. Gray.

Approved at the stated meeting of the Section, December 17, 1893.

Respectfully submitted,

WM. C. DAY, *Secretary.*

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